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**COMMITTEE OF EXPERTS ON THE
TRANSPORT OF DANGEROUS GOODS**

REPORT OF THE COMMITTEE OF EXPERTS ON ITS NINETEENTH SESSION (2-10 December 1996)

Addendum 3

Annex 5

Chapter 4.2: Use of portable tanks

Chapter 6.6: Requirements for the design, construction, inspection and testing of portable tanks

GE.97-20484

CHAPTER 4.2

USE OF PORTABLE TANKS

4.2.1 General requirements for the use of portable tanks for the transport of substances of Classes 3 to 9

4.2.1.1 This section provides general requirements applicable to the use of portable tanks for the transport of substances of Classes 3, 4, 5, 6, 7, 8 and 9. In addition to these general requirements, portable tanks shall conform to the design, construction, inspection and testing requirements detailed in 6.6.2. Substances shall be transported in portable tanks conforming to the applicable portable tank instruction identified in Column 10 of the Dangerous Goods List and described in 4.2.4.2.6 (T1 to T34, T50 and T75) and the portable tank special provisions assigned to each substance in Column 11 of the Dangerous Goods List.

4.2.1.2 During transport, portable tanks shall be adequately protected against damage to the shell and service equipment resulting from lateral and longitudinal impact and overturning. If the shell and service equipment are so constructed as to withstand impact or overturning it need not be protected in this way. Examples of such protection are given in 6.6.2.17.5.

4.2.1.3 Certain substances are chemically unstable. They are accepted for transport only when the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care shall in particular be taken to ensure that shells do not contain any substances liable to promote these reactions.

4.2.1.4 The temperature of the outer surface of the shell excluding openings and their closures or of the thermal insulation shall not exceed 70 °C during transport. When dangerous goods are transported at elevated temperatures in either liquid or solid state, the shell shall be thermally insulated to meet this condition.

4.2.1.5 Empty portable tanks not cleaned and not gas-free shall comply with the same requirements as portable tanks filled with the previous substance.

4.2.1.6 Substances shall not be transported in adjoining compartments of shells when they may react dangerously with each other and cause:

(a) combustion and/or evolution of considerable heat;

(b) evolution of flammable, toxic or asphyxiant gases;

(c) the formation of corrosive substances;

(d) the formation of unstable substances;

(e) dangerous rise in pressure.

4.2.1.7 The design approval certificate, the test report and the certificate showing the results of the initial inspection and test for each portable tank issued by the competent authority or its authorized body shall be retained by the authority or body and the owner. Owners shall be able to provide this documentation upon the request of any competent authority.

4.2.1.8 Unless the name of the substance(s) being transported appears on the metal plate described in 6.6.2.20.2, a copy of the certificate specified in 6.6.2.18.1 shall be made available upon the request of a competent authority or its authorized body and readily provided by the consignor, consignee or agent, as appropriate.

4.2.1.9 *Filling ratios*

4.2.1.9.1 Prior to filling, the shipper shall ensure that the appropriate portable tank is used and that the portable tank is not loaded with substances which in contact with the materials of the shell, gaskets, service equipment and any protective linings, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. The shipper may need to consult the manufacturer of the substance in conjunction with the competent authority for guidance on the compatibility of the substance with the portable tank materials.

4.2.1.9.1.1 Portable tanks shall not be filled above the extent provided in 4.2.1.9.2 to 4.2.1.9.6. The applicability of 4.2.1.9.2, 4.2.1.9.3 or 4.2.1.9.5.1 to individual substances is specified in the applicable portable tank special provisions in Part 4.2.4.3 and column 11 of the Dangerous Goods List.

4.2.1.9.2 The maximum degree of filling (in %) for general use is determined by the formula:

$$Degree\ of\ filling = \frac{97}{1 + \alpha\ (t_r - t_f)}$$

4.2.1.9.3 The maximum degree of filling (in %) for liquids of Division 6.1 and Class 8, in Packing Groups I and II, and liquids with an absolute vapour pressure of more than 175 kPa (1.75 bar) at 65 °C, is determined by the formula:

$$Degree\ of\ filling = \frac{95}{1 + \alpha\ (t_r - t_f)}$$

4.2.1.9.4 In these formulae, α is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (t_f) and the maximum mean bulk temperature during transport (t_r) (both in °C). For liquids transported under ambient conditions α could be calculated by the formula:

$$\alpha = \frac{d_{15} - d_{50}}{35\ d_{50}}$$

in which d_{15} and d_{50} are the densities of the liquid at 15 °C and 50 °C, respectively.

4.2.1.9.4.1 The maximum mean bulk temperature (t_r) shall be taken as 50 °C except that, for journeys under temperate or extreme climatic conditions, the competent authorities concerned may agree to a lower or require a higher temperature, as appropriate.

4.2.1.9.5 The requirements of 4.2.1.9.2 to 4.2.1.9.4.1 do not apply to portable tanks which contain substances maintained at a temperature above 50 °C during transport (e.g. by means of a heating device). For portable tanks equipped with a heating device, a temperature regulator shall be used to ensure the maximum degree of filling is not more than 95% full at any time during transport.

4.2.1.9.5.1 The maximum degree of filling (in %) for liquids transported under elevated temperature conditions is determined by the formula:

$$Degree\ of\ filling = 95\ \frac{d_r}{d_f}$$

in which d_f and d_r are the densities of the liquid at the mean temperature of the liquid during filling and the maximum mean bulk temperature during transport respectively.

4.2.1.9.6 Portable tanks shall not be offered for transport:

(a) with a degree of filling, for liquids having a viscosity less than 2,680 mm^2/s at 20 °C, of more than 20% but less than 80% unless the shells of portable tanks are divided, by partitions or surge plates, into sections of not more than 7,500 litres capacity;

(b) with residue of goods previously transported adhering to the outside of the shell or service equipment;

(c) when leaking or damaged to such an extent that the integrity of the portable tank or its lifting or securing arrangements may be affected; and

(d) unless the service equipment has been examined and found to be in good working order.

4.2.1.10 *Additional general requirements applicable to the transport of Class 3 substances in portable tanks*

4.2.1.10.1 All portable tanks intended for the transport of flammable liquids shall be closed and be fitted with relief devices in accordance with 6.6.2.8 to 6.6.2.15.

4.2.1.10.1.1 For portable tanks intended for use only on land, the pertinent regulations governing transport by land may allow open venting systems.

4.2.1.11 *Additional general requirements applicable to the transport of Class 4 substances in portable tanks*

4.2.1.11.1 No specific additional requirements apply to Class 4 substances. In general, Division 4.1 substances can be carried safely in containers other than portable tanks.

4.2.1.12 *Additional general requirements applicable to the transport of Division 5.1 substances in portable tanks*

[Reserved]

4.2.1.13 *Additional general requirements applicable to the transport of Division 5.2 substances in portable tanks*

4.2.1.13.1 Each organic peroxide shall have been tested and a report submitted to the competent authority of the country of origin for approval. Notification thereof shall be sent to the competent authority of the country of destination. The notification shall contain relevant transport information and the report with test results. The tests undertaken shall include those necessary:

(a) to prove the compatibility of all materials normally in contact with the substance during transport;

(b) to provide data for the design of the pressure and emergency relief devices taking into account the design characteristics of the portable tank.

Any special requirements necessary for safe transport of the substance shall be clearly described in the report.

4.2.1.13.2 The following requirements apply to portable tanks intended for the transport of organic peroxides (Type F) with a Self-Accelerating Decomposition Temperature (SADT) of 55 °C or more. In case of conflict these requirements prevail over those specified in Section 6.6.2. Emergencies to be taken into account are self-accelerating decomposition of the organic peroxide and fire-engulfment as described in 4.2.1.13.8.

4.2.1.13.3 The additional requirements for transport of organic peroxides with an SADT less than 55 °C in portable tanks shall be specified by the competent authority of the country of origin. Notification thereof shall be sent to the competent authority of the country of destination.

4.2.1.13.4 The portable tank shall be designed for a test pressure of at least 0.4 MPa (4 bar).

4.2.1.13.5 Portable tanks shall be fitted with temperature sensing devices.

4.2.1.13.6 Portable tanks shall be fitted with pressure-relief devices and emergency-relief devices. Vacuum-relief devices may also be used. Pressure-relief devices shall operate at pressures determined according to both the properties of the organic peroxide and the construction characteristics of the portable tank. Fusible elements are not allowed in the shell.

4.2.1.13.7 The pressure-relief devices shall consist of spring-loaded valves fitted to prevent significant build-up within the portable tank of the decomposition products and vapours released at a temperature of 50 °C. The capacity and start-to-discharge pressure of the relief valves shall be based on the results of the tests specified in 4.2.1.13.1. The start-to-discharge pressure shall, however, in no case be such that liquid would escape from the valve(s) if the portable tank were overturned.

4.2.1.13.8 The emergency-relief devices may be of the spring-loaded or frangible types designed to vent all the decomposition products and vapours evolved during a period of not less than one hour of complete fire-engulfment as calculated by the following formula:

$$q = 70961\ F\ A^{0.82}$$

where:

q	=	heat absorption (W)	
A	=	wetted area [m^2]	
F	=	insulation factor [-];	
F	=	1 for non-insulated vessels, or	
F	=	$\frac{U\ (923\ -\ T_{PO})}{47032}$ for insulated vessels	

where:

K	=	heat conductivity of insulation layer	[$W.m^{-1}.K^{-1}$]
L	=	thickness of insulation layer	[m]
U	=	K/L = heat transfer coefficient of the insulation	[$W.m^{-2}.K^{-1}$]
T_{PO}	=	temperature of peroxide at relieving conditions	[K]

The start-to-discharge pressure of the emergency-relief device(s) shall be higher than that specified in 4.2.1.13.7 and based on the results of the tests referred to in 4.2.1.13.1. The emergency-relief devices shall be dimensioned in such a way that the maximum pressure in the tank never exceeds the test pressure of the tank.

***NOTE** : An example of a method to determine the size of emergency-relief devices is given in Appendix 5 of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.*

4.2.1.13.9 For insulated portable tanks the capacity and setting of emergency-relief device(s) shall be determined assuming a loss of insulation from 1% of the surface area.

4.2.1.13.10 Vacuum-relief devices and spring-loaded valves shall be provided with flame arresters. Due attention shall be paid to the reduction of the relief capacity caused by the flame arrester.

4.2.1.13.11 Service equipment such as valves and external piping shall be so arranged that no organic peroxide remains in them after filling the portable tank.

4.2.1.13.12 Portable tanks may be either insulated or protected by a sun-shield. If the SADT of the organic peroxide in the portable tank is 55 °C or less, or the portable tank is constructed of aluminium, the portable tank shall be completely insulated. The outer surface shall be finished in white or bright metal.

4.2.1.13.13 The degree of filling shall not exceed 90% at 15 °C.

4.2.1.13.14 The marking as required in 6.6.2.20.2 shall include the UN number and the technical name with the approved concentration of the organic peroxide concerned.

4.2.1.13.15 Organic peroxides specifically listed in portable tank instruction T34 in 4.2.4.2.6 may be transported in portable tanks.

4.2.1.14 *Additional general requirements applicable to the transport of Division 6.1 substances in portable tanks*

[reserved]

4.2.1.15 *Additional general requirements applicable to the transport of Class 7 substances in portable tanks*

4.2.1.15.1 Use of portable tanks for the transport of radioactive material shall, in addition to the requirements of these regulations, comply with the IAEA Transport Regulations (Regulations for the Safe Transport of Radioactive Material (1996 Edition), IAEA Safety Standards Series No.ST-1).

4.2.1.15.2 Portable tanks used for the transport of radioactive material shall not be used for the transport of other goods.

4.2.1.15.3 The degree of filling for portable tanks shall not exceed 90% or, alternatively, any other value approved by the competent authority.

4.2.1.16 *Additional general requirements applicable to the transport of Class 8 substances in portable tanks*

4.2.1.16.1 Pressure-relief devices of portable tanks used for the transport of Class 8 substances shall be inspected at intervals not exceeding one year.

4.2.1.17 *Additional general requirements applicable to the transport of Class 9 substances in portable tanks*

[reserved]

4.2.2 General requirements for the use of portable tanks for the transport of non-refrigerated liquefied gases

4.2.2.1 This section provides general requirements applicable to the use of portable tanks for the transport of non-refrigerated liquefied gases.

4.2.2.2 Portable tanks shall conform to the design, construction, inspection and testing requirements detailed in 6.6.3. Non-refrigerated liquefied gases shall be transported in portable tanks conforming to portable tank instruction T50 as described in 4.2.4.2.6 and any portable tank special provisions assigned to specific refrigerated liquefied gases in Column 11 of the Dangerous Goods List and described in 4.2.4.3.

4.2.2.3 During transport, portable tanks shall be adequately protected against damage to the shell and service equipment resulting from lateral and longitudinal impact and overturning. If the shell and service equipment are so constructed as to withstand impact or overturning it need not be protected in this way. Examples of such protection are given in 6.6.3.13.5.

4.2.2.4 Certain non-refrigerated liquefied gases are chemically unstable. They are accepted for transport only when the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care shall in particular be taken to ensure that portable tanks do not contain any non-refrigerated liquefied gases liable to promote these reactions.

4.2.2.5 Unless the name of the dangerous goods being transported appears on the metal plate described in 6.6.3.16.2, a copy of the certificate specified in 6.6.3.14.1 shall be made available upon a competent authority request and readily provided by the consignor, consignee or agent, as appropriate.

4.2.2.6 Empty portable tanks not cleaned and not gas-free shall comply with the same requirements as portable tanks filled with the previous non-refrigerated liquefied gas.

4.2.2.7 *Filling*

4.2.2.7.1 Prior to filling the shipper shall ensure that the portable tank is approved for the non-refrigerated liquefied gas to be transported and that the portable tank is not loaded with non-refrigerated liquefied gases which in contact with the materials of the shell, gaskets and service equipment, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. During filling, the temperature of the non-refrigerated liquefied gas shall fall within the limits of the design temperature range.

4.2.2.7.2 The maximum mass of non-refrigerated liquefied gas per litre of shell capacity (kg/l) shall not exceed the density of the non-refrigerated liquefied gas at 50 °C multiplied by 0.95. Furthermore, the shell shall not be liquid-full at 60 °C.

4.2.2.7.3 Portable tanks shall not be filled above their maximum permissible gross mass and the maximum permissible load mass specified for each gas to be transported.

4.2.2.8 Portable tanks shall not be offered for transport:

(a) in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the portable tank;

(b) when leaking;

(c) when damaged to such an extent that the integrity of the tank or its lifting or securing arrangements may be affected; and

(d) unless the service equipment has been examined and found to be in good working order.

4.2.3 General requirements for the use of portable tanks for the transport of refrigerated liquefied gases

4.2.3.1 This section provides general requirements applicable to the use of portable tanks for the transport of refrigerated liquefied gases.

4.2.3.2 Portable tanks shall conform to the design, construction, inspection and testing requirements detailed in 6.6.3. Refrigerated liquefied gases shall be transported in portable tanks conforming to portable tank instruction T75 as described in 4.2.4.2.6 and the portable tank special provisions assigned to each substance in the Dangerous Goods List and described in 4.2.4.3.

4.2.3.3 During transport, portable tanks shall be adequately protected against damage to the shell and service equipment resulting from lateral and longitudinal impact and overturning. If the shell and service equipment are so constructed as to withstand impact or overturning it need not be protected in this way. Examples of such protection are provided in 6.6.4.12.5.

4.2.3.4 Unless the name of the dangerous goods being transported appears on the metal plate described in 6.6.4.15.2, a copy of the certificate specified in 6.6.4.13.1 shall be made available upon a competent authority request and readily provided by the consignor, consignee or agent, as appropriate.

4.2.3.5 Empty portable tanks not cleaned and not gas-free shall comply with the same requirements as portable tanks filled with the previous substance.

4.2.3.6 *Filling*

4.2.3.6.1 Prior to filling the shipper shall ensure that the portable tank is approved for the refrigerated liquefied gas to be transported and that the portable tank is not loaded with refrigerated liquefied gases which in contact with the materials of the shell, gaskets and service equipment, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. During filling, the temperature of the refrigerated liquefied gas shall be within the limits of the design temperature range.

4.2.3.6.2 In estimating the initial degree of filling the necessary holding time for the intended journey including any delays which might be encountered shall be taken into consideration. The initial degree of filling of the shell, except as provided for in 4.2.3.6.3 and 4.2.3.6.4, shall be such that if the contents, except helium, were to be raised to a temperature at which the vapour pressure is equal to the maximum allowable working pressure (MAWP) the volume occupied by liquid would not exceed 98%.

4.2.3.6.3 Shells intended for the transport of helium can be filled up to but not above the inlet of the pressure-relief device.

4.2.3.6.4 A higher initial degree of filling may be allowed, subject to approval by the competent authority, when the intended duration of transport is considerably shorter than the holding time.

4.2.3.7 *Actual holding time*

The actual holding time shall be calculated for each journey in accordance with a procedure recognized by the competent authority, on the basis of the following:

(a) the reference holding time for the refrigerated liquefied gas to be transported (see 6.6.4.2.8.1) (as indicated on the plate referred to in 6.6.4.15.1)

(b) the actual filling density;

(c) the actual filling pressure;

(d) the lowest set pressure of the pressure limiting device(s).

4.2.3.7.1 The actual holding time shall be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank, in accordance with 6.6.4.15.2.

4.2.3.8 Portable tanks shall not be offered for transport:

(a) in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the shell;

(b) when leaking;

(c) when damaged to such an extent that the integrity of the portable tank or its lifting or securing arrangements may be affected;

(d) unless the service equipment has been examined and found to be in good working order;

(e) unless the actual holding time for the refrigerated liquefied gas being transported has been determined in accordance with 4.2.3.7 and the portable tank is marked in accordance with 6.6.4.15.2; and

(f) unless the duration of transport, after taking into consideration any delays which might be encountered, does not exceed the actual holding time.

4.2.4 Portable tank instructions and special provisions

4.2.4.1 *General*

4.2.4.1.1 This section includes the portable tank instructions and special provisions applicable to dangerous goods authorized to be transported in portable tanks. Each portable tank instruction is identified by an alpha-numeric designation (T1 to T36). Column 10 of the Dangerous Goods List in Chapter 3.2 indicates the portable tank instruction that shall be used for each substance permitted for transport in a portable tank. When no portable tank instruction appears in Column 10 for a specific dangerous goods entry then transport of the substance in portable tanks is not permitted unless a competent authority approval is granted as detailed in 6.6.1.3. Portable tank special provisions are assigned to specific dangerous goods in Column 11 of the Dangerous Goods List in Chapter 3.2. Each portable tank special provision is identified by an alpha-numeric designation (TP1 to T24). A listing of the portable tank special provisions is provided in 4.2.4.3.

4.2.4.2 *Portable tank instructions*

4.2.4.2.1 Portable tank instructions apply to dangerous goods of Classes 2 to 9. Portable tank instructions provide specific information relevant to portable tanks requirements applicable to specific substances. These requirements shall be met in addition to the general requirements in this Chapter and Chapter 6.6.

4.2.4.2.2 For substances of Classes 3 to 9, the portable tank instructions (T1 - T34) indicate the applicable minimum test pressure, the minimum shell thickness (in reference steel), bottom opening requirements and pressure relief requirements. In T34, Division 5.2, organic peroxides permitted to be transported in portable tanks are listed along with applicable control and emergency temperatures.

4.2.4.2.3 Non-refrigerated liquefied gases are assigned to portable tank instruction T50. T50 provides the maximum allowable working pressures, bottom opening requirements, pressure relief requirements

and degree of filling requirements for non-refrigerated liquefied gases permitted for transport in portable tanks.

4.2.4.2.4 Refrigerated liquefied gases are assigned to portable tank instruction T75.

4.2.4.2.5 Determination of the appropriate portable tank instructions

When a specific portable tank instruction is specified in Column 10 for a specific dangerous goods entry additional portable tanks which possess higher test pressures, greater wall thicknesses, more stringent bottom opening and pressure relief device arrangements may be used. The following guidelines apply to determining the appropriate portable tanks which may be used for transport of particular substances:

Portable tank instruction specified	**Portable tank instructions also permitted**
T1	T2 to T33
T2	T4 to T33
T3	T4 to T33
T4	T5 to T33
T5	T6, T8, T9, T11, T12, T15, T16, T19, T20, T21, T22, T23, T26, T27, T29, T30, T31, T32, T33
T6	T9, T12, T16, T20, T22, T23, T27, T29, T30, T31, T33
T7	T8 to T12, T17 to T23, T28 to T33
T8	T9, T11, T12, T15, T19, T20, T21, T22, T23, T29 to T33
T9	T12, T20, T22, T23, T29, T30, T31, T33
T10	T11, T12, T21, T22, T23, T30, T32, T33
T11	T12, T21, T22, T23, T30, T32, T33
T12	T22, T23, T30, T33
T13	T14 to T33
T14	T16, T18, T20, T22, T23, T25, T29, T30, T31, T33
T15	T16, T19, T20, T21, T22, T23, T26, T27, T29, to T33
T16	T20, T22, T23, T27, T29, T30, T31, T33

Portable tank instruction specified	Portable tank instructions also permitted
T17	T18 to T23, T28 to T33
T18	T20, T22, T23, T29, T30, T31, T33
T19	T20, T21, T22, T23, T29, T30, T31, T32, T33
T20	T22, T23, T29, T30, T31, T33
T21	T22, T23, T30, T32, T33
T22	T23, T30, T33
T23	None
T24	T25 to T33
T25	T27, T29, T30, T31, T33
T26	T27, T29 to T33
T27	T29, T30, T31, T33
T28	T29 to T33
T29	T30, T31
T30	T33
T31	T33
T32	T33
T33	None

4.2.4.2.6 Portable tank instructions

T1 - T33	PORTABLE TANK INSTRUCTIONS			T1 -T33
These portable tank instructions apply to liquid and solid substances of Classes 3 to 9. The general requirements of Section 4.2.1 and the requirements of Section 6.6.2 shall be met.				
Portable tank instruction	**Minimum test pressure (bar)**	**Minimum shell thickness (in mm-reference steel) (see 6.2.4)**	**Bottom opening requirements (see 6.6.2.6)**	**Pressure relief requirements (see 6.6.2.8)**
T1	1.5	See 6.6.2.4.2	See 6.6.2.6.2	Normal
T2	1.5	See 6.6.2.4.2	See 6.6.2.6.3	Normal
T3	2.65	See 6.6.2.4.2	See 6.6.2.6.2	Normal
T4	2.65	See 6.6.2.4.2	See 6.6.2.6.3	Normal
T5	2.65	See 6.6.2.4.2	Not allowed	Normal
T6	2.65	See 6.6.2.4.2	Not allowed	See 6.6.2.8.3
T7	2.65	6mm	See 6.6.2.6.3	Normal
T8	2.65	6mm	Not allowed	Normal
T9	2.65	6mm	Not allowed	See 6.6.2.8.3
T10	2.65	8mm	See 6.6.2.6.3	Normal
T11	2.65	8mm	Not allowed	Normal
T12	2.65	8mm	Not allowed	See 6.6.2.8.3
T13	4	See 6.6.2.4.2	See 6.6.2.6.3	Normal
T14	4	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.3
T15	4	See 6.6.2.4.2	Not allowed	Normal
T16	4	See 6.6.2.4.2	Not allowed	See 6.6.2.8.3
T17	4	6mm	See 6.6.2.6.3	Normal
T18	4	6mm	See 6.6.2.6.3	See 6.6.2.8.3
T19	4	6mm	Not allowed	Normal
T20	4	6mm	Not allowed	See 6.6.2.8.3
T21	4	8mm	Not allowed	Normal

T1 - T33 **PORTABLE TANK INSTRUCTIONS** **T1 -T33**

These portable tank instructions apply to liquid and solid substances of Classes 3 to 9. The general requirements of Section 4.2.1 and the requirements of Section 6.6.2 shall be met.

Portable tank instruction	Minimum test pressure (bar)	Minimum shell thickness (in mm-reference steel) (see 6.2.4)	Bottom opening requirements (see 6.6.2.6)	Pressure relief requirements (see 6.6.2.8)
T22	4	8mm	Not allowed	See 6.6.2.8.3
T23	4	12mm	Not allowed	See 6.6.2.8.3
T24	6	See 6.6.2.4.2	See 6.6.2.6.3	Normal
T25	6	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.3
T26	6	See 6.6.2.4.2	Not allowed	Normal
T27	6	See 6.6.2.4.2	Not allowed	See 6.6.2.8.3
T28	6	6mm	See 6.6.2.6.3	Normal
T29	6	6mm	Not allowed	See 6.6.2.8.3
T30	6	8mm	Not allowed	See 6.6.2.8.3
T31	10	6mm	Not allowed	See 6.6.2.8.3
T32	10	10mm	Not allowed	Normal
T33	10	10mm	Not allowed	See 6.6.2.8.3

T34 **PORTABLE TANK INSTRUCTION** **T34**

This portable tank instruction applies to Division 5.2, organic peroxides. The general requirements of Section 4.2.1 and the requirements of Section 6.6.2 shall be met. The requirements specific to Division 5.2 substances in 4.2.1.13 shall also be met.

UN No.	Organic peroxides	Minimum test pressure (bar)	Minimum shell thickness (mm-reference steel)	Bottom opening requir-ements	Pressure relief requir-ements	Filling limits	Control temp-erature	Emer-gency temp-erature
3109	ORGANIC PEROXIDE, TYPE F, LIQUID tert-Butyl hydroperoxide 1/, not more than 72% with water Cumyl hydroperoxide, not more than 90% in diluent type A Di-tert-butyl peroxide, not more than 32% in diluent type A Isopropyl cumyl hydro-peroxide, not more than 72% in diluent type A p-Menthyl hydro-peroxide, not more than 72% in diluent type A Pinanyl hydro-peroxide, not more than 50% in diluent type A	4	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.2 4.2.1.13.6 4.2.1.13.7 4.2.1.13.8	See 4.2.1.13.13		

1/ *Provided that steps have been taken to achieve the safety equivalence of 65 % tert-Butyl hydroperoxide and 35 % water.*

T34 **PORTABLE TANK INSTRUCTION** **T34**

This portable tank instruction applies to Division 5.2, organic peroxides. The general requirements of Section 4.2.1 and the requirements of Section 6.6.2 shall be met. The requirements specific to Division 5.2 substances in 4.2.1.13 shall also be met.

UN No.	Organic peroxides	Minimum test pressure (bar)	Minimum shell thickness (mm-reference steel)	Bottom opening requirements	Pressure relief requirements	Filling limits	Control temperature	Emergency temperature
3110	ORGANIC PEROXIDE TYPE F, SOLID Dicumyl peroxide 2/	4	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.2 4.2.1.13.6 4.2.1.13.7 4.2.1.13.8	See 4.2.1.13.13		
3119	ORGANIC PEROXIDE, TYPE F, LIQUID, TEMPERATURE CONTROLLED	4	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.2 4.2.1.13.6 4.2.1.13.7 4.2.1.13.8	See 4.2.1.13.13		
	tert-Butyl peroxyacetate, not more than 32% in diluent type B						+30°C	+35°C
	tert-Butyl peroxy-2-ethylhexanoate, not more than 32% in diluent type B						+10°C	+15°C
	tert-Butyl peroxypivalate, not more than 27% in diluent type B						-5°C	+5 °C
	tert-Butyl peroxy-3,5,5-trimethyl-hexanoate, not more than 32% in diluent type B						+35°C	+40°C
	Di-(3,5,5-trimethyl-hexanoyl) peroxide, not more than 38% in diluent type A						-10°C	0°C

2/ *Maximum quantity per receptacle 2,000 kg.*

T34 **PORTABLE TANK INSTRUCTION** **T34**

This portable tank instruction applies to Division 5.2, organic peroxides. The general requirements of Section 4.2.1 and the requirements of Section 6.6.2 shall be met. The requirements specific to Division 5.2 substances in 4.2.1.13 shall also be met.

UN No.	Organic peroxides	Minimum test pressure (bar)	Minimum shell thickness (mm-reference steel)	Bottom opening requir-ements	Pressure relief requir-ements	Filling limits	Control temp-erature	Emer-gency temp-erature
3120	ORGANIC PEROXIDE, TYPE F, SOLID, TEMPERATURE CONTROLLED	4	See 6.6.2.4.2	See 6.6.2.6.3	See 6.6.2.8.2 4.2.1.13.6 4.2.1.13.7 4.2.1.13.8	See 4.2.1.13.13		

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
1005	Ammonia, anhydrous	29.0 25.7 22.0 19.7	Allowed	See 6.6.3.7.3	0.53
1009	Bromotrifluoromethane (Refrigerant gas R 13B1)	38.0 34.0 30.0 27.5	Allowed	Normal	1.13
1010	Butadienes, inhibited	7.5 7.0 7.0 7.0	Allowed	Normal	0.55
1011	Butane	7.0 7.0 7.0 7.0	Allowed	Normal	0.51

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
1012	Butylene	8.0 7.0 7.0 7.0	Allowed	Normal	0.53
1017	Chlorine	19.0 17.0 15.0 13.5	Not Allowed	See 6.6.3.7.3	1.25
1018	Chlorodifluoromethane (Refrigerant gas R 22)	26.0 24.0 21.0 19.0	Allowed	Normal	1.03
1020	Chloropentafluoroethane (Refrigerant gas R 115)	23.0 20.0 18.0 16.0	Allowed	Normal	1.06
1021	1-Chloro-1,2,2,2-tetrafluoroethane (Refrigerant gas R 124)	10.3 9.8 7.9 7.0	Allowed	Normal	1.20
1027	Cyclopropane	18.0 16.0 14.5 13.0	Allowed	Normal	0.53
1028	Dichlorodifluoromethane (Refrigerant gas R 12)	16.0 15.0 13.0 11.5	Allowed	Normal	1.15
1029	Dichlorofluoromethane (Refrigerant gas R 21)	7.0 7.0 7.0 7.0	Allowed	Normal	1.23

T50	PORTABLE TANK INSTRUCTION				T50
This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.					
UN No.	**Non-refrigerated liquefied gases**	**Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated**	**Openings below liquid level**	**Pressure relief requirements (see 6.6.3.7)**	**Maximum filling ratio (kg/l)**
1030	1,1-Difluoroethane (Refrigerant gas R 152a)	16.0 14.0 12.4 11.0	Allowed	Normal	0.79
1032	Dimethylamine, anhydrous	7.0 7.0 7.0 7.0	Allowed	Normal	0.59
1033	Dimethyl ether	15.3 13.8 12.0 10.6	Allowed	Normal	0.58
1036	Ethylamine	7.0 7.0 7.0 7.0	Allowed	Normal	0.61
1037	Ethyl chloride	7.0 7.0 7.0 7.0	Allowed	Normal	0.80
1040	Ethylene oxide with nitrogen up to a total pressure of 1MPa (10 bar) at 50 °C	- - - 10.0	Not Allowed	See 6.6.3.7.3	0.78
1041	Ethylene oxide and carbon dioxide mixture with more than 9 % but not more than 87 % ethylene oxide	See MAWP definition in 6.6.3.1	Allowed	Normal	See 4.2.2.7
1055	Isobutylene	8.1 7.0 7.0 7.0	Allowed	Normal	0.52
1061	Methylamine, anhydrous	10.8 9.6 7.8 7.0	Allowed	Normal	0.58

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
1062	Methyl bromide	7.0 7.0 7.0 7.0	Not Allowed	See 6.6.3.7.3	1.51
1063	Methyl chloride (Refrigerant gas R40)	14.5 12.7 11.3 10.0	Allowed	Normal	0.81
1064	Methyl mercaptan	7.0 7.0 7.0 7.0	Not Allowed	See 6.6.3.7.3	0.78
1067	Dinitrogen tetroxide	7.0 7.0 7.0 7.0	Not Allowed	See 6.6.3.7.3	1.30
1075	Petroleum gas, liquefied	See MAWP definition in 6.6.3.1	Allowed	Normal	See 4.2.2.7
1077	Propylene	28.0 24.5 22.0 20.0	Allowed	Normal	0.43
1079	Sulphur dioxide	11.6 10.3 8.5 7.6	Not Allowed	See 6.6.3.7.3	1.23
1082	Trifluorochloroethylene, inhibited (Refrigerant gas R 1113)	17.0 15.0 13.1 11.6	Not Allowed	See 6.6.3.7.3	1.13
1083	Trimethylamine, anhydrous	7.0 7.0 7.0 7.0	Allowed	Normal	0.56

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
1085	Vinyl bromide, inhibited	7.0 7.0 7.0 7.0	Allowed	Normal	1.37
1086	Vinyl chloride, inhibited or stabilized	10.6 9.3 8.0 7.0	Allowed	Normal	0.81
1087	Vinyl methyl ether, inhibited	7.0 7.0 7.0 7.0	Allowed	Normal	0.67
1581	Chloropicrin and methyl bromide mixture	7.0 7.0 7.0 7.0	Not Allowed	See 6.6.3.7.3	1.51
1582	Chloropicrin and methyl chloride mixture	19.2 16.9 15.1 13.1	Not Allowed	See 6.6.3.7.3	0.81
1858	Hexafluoropropylene (Refrigerant gas R 1216)	19.2 16.9 15.1 13.1	Allowed	Normal	1.11
1912	Methyl chloride and methylene chloride mixture	15.2 13.0 11.6 10.1	Allowed	Normal	0.81
1958	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Refrigerant gas R 114)	7.0 7.0 7.0 7.0	Allowed	Normal	1.30
1965	Hydrocarbon gas, mixture liquefied, n.o.s.	See MAWP definition in 6.6.3.1	Allowed	Normal	See 4.2.2.7

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
1969	Isobutane	8.5 7.5 7.0 7.0	Allowed	Normal	0.49
1973	Chlorodifluoromethane and chloropentafluoroethane mixture with fixed boiling point, with approximately 49 % chlorodifluoromethane (Refrigerant gas R 502)	28.3 25.3 22.8 20.3	Allowed	Normal	1.05
1974	Chlorodifluorobromomethane (Refrigerant gas R 12B1)	7.4 7.0 7.0 7.0	Allowed	Normal	1.61
1976	Octafluorocyclobutane (Refrigerant gas RC 318)	8.8 7.8 7.0 7.0	Allowed	Normal	1.34
1978	Propane	22.5 20.4 18.0 16.5	Allowed	Normal	0.42
1983	1-Chloro-2,2,2-trifluoroethane (Refrigerant gas R 133a)	7.0 7.0 7.0 7.0	Allowed	Normal	1.18
2424	Octafluoropropane (Refrigerant gas R 218)	23.1 20.8 18.6 16.6	Allowed	Normal	1.07
2517	1-Chloro-1,1-difluoroethane (Refrigerant gas R 142b)	8.9 7.8 7.0 7.0	Allowed	Normal	0.99

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
2602	Dichlorodifluoromethane and difluoroethane azeotropic mixture with approximately 74 % dichlorodifluoromethane (Refrigerant gas R 500)	20.0 18.0 16.0 14.5	Allowed	Normal	1.01
3159	1,1,1,2-Tetrafluoroethane (Refrigerant gas R 134a)	17.7 15.7 13.8 12.1	Allowed	Normal	1.04
3220	Pentafluoroethane (Refrigerant gas R 125)	34.4 30.8 27.5 24.5	Allowed	Normal	0.95
3252	Difluoromethane (Refrigerant gas R 32)	43.0 39.0 34.4 30.5	Allowed	Normal	0.78
3296	Heptafluoropropane (Refrigerant gas R 227)	16.0 14.0 12.5 11.0	Allowed	Normal	1.20
3297	Ethylene oxide and chlorotetrafluoroethane mixture, with not more than 8.8 % ethylene oxide	8.1 7.0 7.0 7.0	Allowed	Normal	1.16
3298	Ethylene oxide and pentafluoroethane mixture, with not more than 7.9 % ethylene oxide	25.9 23.4 20.9 18.6	Allowed	Normal	1.02
3299	Ethylene oxide and tetrafluoroethane mixture, with not more than 5.6 % ethylene oxide	16.7 14.7 12.9 11.2	Allowed	Normal	1.03

T50 **PORTABLE TANK INSTRUCTION** **T50**

This portable tank instruction applies to non-refrigerated liquefied gases. The general requirements of Section 4.2.2 and the requirements of Section 6.6.3 shall be met.

UN No.	Non-refrigerated liquefied gases	Max. allowable working pressure (bar) Small; Bare; Sunshield; Insulated	Openings below liquid level	Pressure relief requirements (see 6.6.3.7)	Maximum filling ratio (kg/l)
3318	Ammonia solution, relative density less than 0.880 at 15 °C in water, with more than 50 % ammonia	See MAWP definition in 6.6.3.1	Allowed	See 6.6.3.7.3	See 4.2.2.6
3337	Refrigerant gas R 404A	31.6 28.2 25.2 22.1	Allowed	Normal	0.82
3338	Refrigerant gas R 407A	32.3 29.0 25.7 22.4	Allowed	Normal	0.94
3339	Refrigerant gas R 407B	34.0 30.5 27.0 23.6	Allowed	Normal	0.93
3340	Refrigerant gas R 407C	30.2 27.0 24.1 21.4	Allowed	Normal	0.95

T75 **PORTABLE TANK INSTRUCTION** **T75**

This portable tank instruction applies to refrigerated liquefied gases. The general requirements of Section 4.2.3 and the requirements of Section 6.6.4 shall be met.

4.2.4.3 *Portable tank special provisions*

Portable tank special provisions are assigned to certain substances to indicate requirements which are in addition to or in lieu of those provided by the portable tank instructions or the requirements in Chapter 6.6. Portable tank special provisions are designated using the abbreviation TP (tank provision) and are assigned to specific substances in Column 11 of the Dangerous Goods List in Chapter 3.2. The following is a list of the portable tank special provisions:

TP1 - The filling limits prescribed in 4.2.1.9.2 shall be met.

TP2 - The filling limits prescribed in 4.2.1.9.3 shall be met.

TP3 - For liquids transported under elevated temperature conditions the filling limits prescribed in 4.2.1.9.5.1 shall be met.

TP4 - The degree of filling for portable tanks shall not exceed 90% or, alternatively, any other value approved by the competent authority (see 4.2.1.15.3).

TP5 - Reserved.

TP6 - To prevent the tank bursting in any event, including fire engulfment, it shall be provided with pressure relief devices which are adequate in relation to the capacity of the tank and to the nature of the substance transported. The device shall also be compatible with the substance.

TP7 - Air shall be eliminated from the vapour space by nitrogen or other means.

TP8 - The test pressure for the portable tank may be reduced to 1.5 bar when the flash point of the substances transported is greater than 0 °C.

TP9 - A substance under this description shall only be transported in a portable tank under an approval granted by the competent authority.

TP10 - A lead lining, not less than 5 mm thick, which shall be tested annually, or another suitable lining material approved by the competent authority is required.

TP11 - If the substance is transported in the molten state it shall be transported in an insulated tank which may be heated when necessary.

TP12 - Highly corrosive to steel.

TP13 - Self-contained breathing apparatus shall be provided when this substance is transported.

TP14 - The minimum test pressure shall not be less than 1.5 times the vapour pressure at 65 °C or 10 bar, whichever is greater.

TP15 - This substance may be carried as an aqueous solution (see 3.1.3).

TP16 - The tank shall be fitted with a special device to prevent under-pressure and excess pressure during normal transport conditions. This device shall be approved by the competent authority. Pressure-relief requirements are as indicated in 6.6.2.8.3 to prevent crystallization of the product in the pressure-relief valve.

TP17 - Only inorganic non-combustible materials shall be used for thermal insulation of the tank.

TP18 - Temperature shall be maintained between 18 °C and 40 °C. Portable tanks containing solidified methacrylic acid shall not be reheated during transport.

TP19 - The calculated wall thickness shall be increased by 3 mm. Wall thickness shall be verified ultrasonically at intervals midway between periodic hydraulic tests.

TP20 - This substance shall only be transported in insulated tanks under a nitrogen blanket.

TP21 - The wall thickness shall be not less than 8mm. Tanks shall be hydraulically tested and internally inspected at intervals not exceeding 2.5 years.

TP22 - Lubricant for joints or other devices shall be oxygen compatible.

TP23 - Transport permitted under special conditions prescribed by the competent authorities.

TP24 - The portable tank may be fitted with a device located under maximum filling conditions in the vapour space of the shell to prevent the build up of excess pressure due to the slow decomposition of the substance transported. This device shall also prevent an unacceptable amount of leakage of liquid in the case of overturning or entry of foreign matter into the tank. This device shall be approved by the competent authority or its authorized body.

CHAPTER 6.6

REQUIREMENTS FOR THE DESIGN, CONSTRUCTION, INSPECTION AND TESTING OF PORTABLE TANKS

6.6.1 Application and general requirements

6.6.1.1 The requirements of this Chapter apply to portable tanks intended for the transport of dangerous goods of Classes 2, 3, 4, 5, 6, 7, 8 and 9, by all modes of transport. In addition to the requirements of this Chapter, unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) 1972, as amended, shall be fulfilled by any multimodal portable tank which meets the definition of a "container" within the terms of that Convention. Additional requirements may apply to offshore portable tanks that are handled in open seas.

6.6.1.2 In recognition of scientific and technological advances, the technical requirements of this Chapter may be varied by alternative arrangements. These alternative arrangements shall offer a level of safety not less than that given by the requirements of this Chapter with respect to the compatibility with substances transported and the ability of the portable tank to withstand impact, loading and fire conditions. For international transport, alternative arrangement portable tanks shall be approved by the applicable competent authorities.

6.6.1.3 When a substance is not assigned a portable tank instruction (T1 to T34, T50 or T75) in Column 10 of the Dangerous Goods List in Chapter 3.2, interim approval for transport may be issued by the competent authority of the country of origin. The approval shall be included in the documentation of the consignment and contain as a minimum the information normally provided in the portable tank instructions and the conditions under which the substance shall be transported. Appropriate measures shall be initiated by the competent authority to include the assignment in the Dangerous Goods List.

6.6.2 Requirements for the design, construction, inspection and testing of portable tanks intended for the transport of substances of Classes 3 to 9

6.6.2.1 *Definitions*

For the purposes of this section:

Portable tank means a multimodal tank having a capacity of more than 450 litres used for the transport of substances of Classes 3 to 9. The portable tank includes a shell fitted with service equipment and structural equipment necessary for the transport of dangerous substances. The portable tank shall be capable of being filled and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the shell, and shall be capable of being lifted when full. It shall be designed primarily to be lifted onto a transport vehicle or ship and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks and intermediate bulk containers (IBCs) are not considered to fall within the definition for portable tanks;

Shell means the part of the portable tank which retains the substance intended for transport (tank proper), including openings and their closures, but does not include service equipment or external structural equipment;

Service equipment means measuring instruments and filling, discharge, venting, safety, heating, cooling and insulating devices;

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the shell;

Maximum allowable working pressure (MAWP) means a pressure that shall be not less than the highest of the following pressures measured at the top of the shell while in operating position:

(a) the maximum effective gauge pressure allowed in the shell during filling or discharge; or

(b) the maximum effective gauge pressure to which the shell is designed which shall be not less than the sum of:

(i) the absolute vapour pressure (in bar) of the substance at 65 °C, minus 1 bar; and

(ii) the partial pressure (in bar) of air or other gases in the ullage space being determined by a maximum ullage temperature of 65 °C and a liquid expansion due to an increase in mean bulk temperature of $t_r - t_f$ (t_f = filling temperature, usually 15 °C; t_r = 50 °C, maximum mean bulk temperature).

Design pressure means the pressure to be used in calculations required by a recognized pressure vessel code. The design pressure shall be not less than the highest of the following pressures:

(a) the maximum effective gauge pressure allowed in the shell during filling or discharge; or

(b) the sum of:

(i) the absolute vapour pressure (in bar) of the substance at 65 °C, minus 1 bar;

(ii) the partial pressure (in bar) of air or other gases in the ullage space being determined by a maximum ullage temperature of 65 °C and a liquid expansion due to an increase in mean bulk temperature of $t_r - t_f$ (t_f = filling temperature usually 15°C; t_r=50°C maximum mean bulk temperature); and

(iii) a head pressure determined on the basis of the dynamic forces specified in 6.6.2.2.12, but not less than 0.35 bar.

(c) two thirds of the minimum test pressure specified in the applicable portable tank instruction in 4.2.4.2.6;

Test pressure means the maximum gauge pressure at the top of the shell during the hydraulic pressure test equal to not less than 1.5 times the design pressure. The minimum test pressure for portable tanks intended for specific substances is specified in the applicable portable tank instruction in 4.2.4.2.6;

Leakproofness test means a test using gas subjecting the shell and its service equipment to an effective internal pressure of not less than 25% of the MAWP;

Maximum permissible gross mass (MPGM) means the sum of the tare mass of the portable tank and the heaviest load authorized for transport;

Reference steel means a steel with a tensile strength of 370 N/mm^2 and an elongation at fracture of 27%;

Mild steel means a steel with a guaranteed minimum tensile strength of 360 N/mm^2 to 440 N/mm^2 and a guaranteed minimum elongation at fracture conforming to 6.6.2.3.3.3;

Design temperature range for the shell shall be -40 °C to 50 °C for substances transported under ambient conditions. For substances handled under elevated temperature conditions the design temperature shall be not less than the maximum temperature of the substance during filling, discharge or transport. More severe design temperatures shall be considered for portable tanks subjected to severe climatic conditions.

6.6.2.2 *General design and construction requirements*

6.6.2.2.1 Shells shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. Shells shall be made of metallic materials suitable for forming. The materials shall in principle conform to national or international material standards. For welded shells only a material whose weldability has been fully demonstrated shall be used. Welds shall be skillfully made and afford complete safety. When the manufacturing process or the materials make it necessary, the shells shall be suitably heat-treated to guarantee adequate toughness in the weld and in the heat affected zones. In choosing the material, the design temperature range shall be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. When fine grain steel is used, the guaranteed value of the yield strength shall be not more than 460 N/mm^2 and the guaranteed value of the upper limit of the tensile strength shall be not more than 725 N/mm^2 according to the material specification. Aluminium may only be used as a construction material when indicated in a portable tank special provision assigned to a specific substance in Column 11 of the Dangerous Goods List or when approved by the competent authority. When aluminium is authorized, it shall be insulated to prevent significant loss of physical properties when subjected to a heat load of 110 kW/m^2 for a period of not less than 30 minutes. The insulation shall remain effective at all temperatures less than 649 °C and shall be jacketed with a material with a melting point of not less than 700 °C. Portable tank materials shall be suitable for the external environment in which they may be transported.

6.6.2.2.2 Portable tank shells, fittings, and pipework shall be constructed from materials which are:

(a) substantially immune to attack by the substance(s) intended to be transported; or

(b) properly passivated or neutralized by chemical reaction; or

(c) lined with corrosion-resistant material directly bonded to the shell or attached by equivalent means.

6.6.2.2.3 Gaskets shall be made of materials not subject to attack by the substances intended to be transported.

6.6.2.2.4 When shells are lined, the lining shall be substantially immune to attack by the substance(s) intended to be transported, homogeneous, non porous, free from perforations, sufficiently elastic and compatible with the thermal expansion characteristics of the shell. The lining of every shell, shell fittings and piping shall be continuous, and shall extend around the face of any flange. Where external fittings are welded to the tank, the lining shall be continuous through the fitting and around the face of external flanges.

6.6.2.2.5 Joints and seams in the lining shall be made by fusing the material together or by other equally effective means.

6.6.2.2.6 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.

6.6.2.2.7 The materials of the portable tank, including any devices, gaskets, linings and accessories, shall not adversely affect the substances intended to be transported in the portable tank.

6.6.2.2.8 Portable tanks shall be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

6.6.2.2.9 Portable tanks shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and transport. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the portable tank, have been taken into account.

6.6.2.2.10 A shell which is to be equipped with a vacuum-relief device shall be designed to withstand, without permanent deformation, an external pressure of not less than 0.21 bar above the internal pressure. The vacuum-relief device shall be set to relieve at a vacuum setting not greater than minus (-) 0.21 bar unless the shell is designed for a higher external over pressure, in which case the vacuum-relief pressure of the device to be fitted shall be not greater than the tank design vacuum pressure. A shell that is not to be fitted with a vacuum-relief device shall be designed to withstand, without permanent deformation an external pressure of not less than 0.4 bar above the internal pressure.

6.6.2.2.11 Vacuum-relief devices used on portable tanks intended for the transport of substances meeting the flash point criteria of Class 3, including elevated temperature substances transported at or above their flash point, shall prevent the immediate passage of flame into the shell, or the portable tank shall have a shell capable of withstanding, without leakage an internal explosion resulting from the passage of flame into the shell.

6.6.2.2.12 Portable tanks and their fastenings shall, under the maximum permissible load, be capable of absorbing the following separately applied static forces:

(a) in the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g) */;

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*/ *For calculation purposes* $g = 9.81\ m/s^2$.

(b) horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g) */;

(c) vertically upwards: the MPGM multiplied by the acceleration due to gravity (g) */; and

(d) vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)*/.

6.6.2.2.13 Under each of the forces in 6.6.2.2.12, the safety factor to be observed shall be as follows:

(a) for metals having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or

(b) for metals with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2 % proof strength and, for austenitic steels, the 1 % proof strength.

6.6.2.2.14 The value of yield strength or proof strength shall be the value according to national or international material standards. When austenitic steels are used, the specified minimum values of yield strength or proof strength according to the material standards may be increased by up to 15 % when these greater values are attested in the material inspection certificate. When no material standard exists for the metal in question, the value of yield strength or proof strength used shall be approved by the competent authority.

6.6.2.2.15 Portable tanks shall be capable of being electrically earthed when intended for the transport of substances meeting the flash point criteria of Class 3 including elevated temperature substances transported above their flash point. Measures shall be taken to prevent dangerous electrostatic discharge.

6.6.2.2.16 When required for certain substances by the applicable portable tank instruction in 4.2.4.2.6 or by a portable tank special provision indicated in Column 11 of the Dangerous Goods List, portable tanks shall be provided with additional protection, which may take the form of additional shell thickness or a higher test pressure, the additional shell thickness or higher test pressure being determined in the light of the inherent risks associated with the transport of the substances concerned.

6.6.2.3 *Design criteria*

6.6.2.3.1 Shells shall be of a design capable of being stress-analysed mathematically or experimentally by resistance strain gauges, or by other methods approved by the competent authority.

6.6.2.3.2 Shells shall be designed and constructed to withstand a hydraulic test pressure not less than 1.5 times the design pressure. Specific requirements are laid down for certain substances in the applicable tank instruction indicated in Column 10 of the Dangerous Goods List and described in 4.2.4 or by a portable tank special provision indicated in Column 11 of the Dangerous Goods List. Attention is drawn to the minimum shell thickness requirements for these tanks specified in 6.6.2.4.1 to 6.6.2.4.10.

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*/ *For calculation purposes* $g = 9.81\ m/s^2$.

6.6.2.3.3 For metals exhibiting a clearly defined yield point or characterized by a guaranteed proof strength (0.2% proof strength, generally, or 1% proof strength for austenitic steels) the primary membrane stress σ (sigma) in the shell shall not exceed 0.75 Re or 0.50 Rm, whichever is lower, at the test pressure, where:

Re = yield strength in N/mm^2, or 0.2% proof strength or, for austenitic steels, 1% proof strength;

Rm = minimum tensile strength in N/mm^2.

6.6.2.3.3.1 The values of Re and Rm to be used shall be the specified minimum values according to national or international material standards. When austenitic steels are used, the specified minimum values for Re and Rm according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the metal in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body.

6.6.2.3.3.2 Steels which have a Re/Rm ratio of more than 0.85 are not allowed for the construction of welded shells. The values of Re and Rm to be used in determining this ratio shall be the values specified in the material inspection certificate.

6.6.2.3.3.3 Steels used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/Rm with an absolute minimum of 16% for fine grain steels and 20% for other steels. Aluminium and aluminium alloys used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/6Rm with an absolute minimum of 12%.

6.6.2.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1984 using a 50 mm gauge length.

6.6.2.4 *Minimum shell thickness*

6.6.2.4.1 The minimum shell thickness shall be the greater thickness based on:

(a) the minimum thickness determined in accordance with the requirements of 6.6.2.4.2 to 6.6.2.4.10;

(b) the minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.6.2.3; and

(c) the minimum thickness specified in the applicable portable tank instruction in 4.2.4.2.6 or by a portable tank special provision indicated in Column 11 of the Dangerous Goods List.

6.6.2.4.2 The cylindrical portions, ends (heads) and manhole covers of shells not more than 1.80 m in diameter shall be not less than 5 mm thick in the reference steel or of equivalent thickness in the metal to be used. Shells more than 1.80 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the metal to be used, except that for powdered or granular solid substances of Packing

Group II or III the minimum thickness requirement may be reduced to not less than 5 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.6.2.4.3 When additional protection against shell damage is provided, portable tanks with test pressures less than 2.65 bar, may have the minimum shell thickness reduced, in proportion to the protection provided, as approved by the competent authority. However, shells not more than 1.80 m in diameter shall be not less than 3 mm thick in the reference steel or of equivalent thickness in the metal to be used. Shells more than 1.80 m in diameter shall be not less than 4 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.6.2.4.4 The cylindrical portions, ends (heads) and manhole covers of all shells shall be not less than 3 mm thick regardless of the material of construction.

6.6.2.4.5 The additional protection referred to in 6.6.2.4.3 may be provided by overall external structural protection, such as suitable "sandwich" construction with the outer sheathing (jacket) secured to the shell, double wall construction or by enclosing the shell in a complete framework with longitudinal and transverse structural members.

6.6.2.4.6 The equivalent thickness of a metal other than the thickness prescribed for the reference steel in 6.6.2.4.3 shall be determined using the following equation:

$$e_1 = \frac{21.4 e_o}{\sqrt[3]{Rm_1 \times A_1}}$$

where:

e_1 = required equivalent thickness (in mm) of the metal to be used;

e_o = minimum thickness (in mm) of the reference steel specified in the applicable portable tank instruction identified in Column 10 of the Dangerous Goods List and described in 4.2.4.2.6 or by a portable tank special provision indicated in Column 11 of the Dangerous Goods List;

Rm_1 = guaranteed minimum tensile strength (in N/mm^2) of the metal to be used (see 6.6.2.3.3);

A_1 = guaranteed minimum elongation at fracture (in %) of the metal to be used according to national or international standards.

6.6.2.4.7 When in the applicable portable tank instruction in 4.2.4.2.6, a minimum thickness of 8 mm, 10 mm or 12 mm is specified, it shall be noted that these thicknesses are based on the properties of the reference steel and a shell diameter of 1.80 m. When a metal other than mild steel (see 6.6.2.1) is used or the shell has a diameter of more than 1.80 m, the thickness shall be determined using the following equation:

$$e_1 = \frac{21.4 e_o d_1}{1.8 \sqrt[3]{Rm_1 \times A_1}}$$

where:

e_1 = required equivalent thickness (in mm) of the metal to be used;

e_o = minimum thickness (in mm) of the reference steel specified in the applicable portable tank instruction identified in Column 10 of the Dangerous Goods List and described in 4.2.4.2.6 or by a portable tank special provision indicated in Column 11 of the Dangerous Goods List;

d_1 = diameter of the shell (in m), but not less than 1.80 m;

Rm_1 = guaranteed minimum tensile strength (in N/mm^2) of the metal to be used (see 6.6.2.3.3);

A_1 = guaranteed minimum elongation at fracture (in %)of the metal to be used according to national or international standards.

6.6.2.4.8 In no case shall the wall thickness be less than that prescribed in 6.6.2.4.2, 6.6.2.4.3 and 6.6.2.4.4. All parts of the shell shall have a minimum thickness as determined by 6.6.2.4.2 to 6.6.2.4.4. This thickness shall be exclusive of any corrosion allowance.

6.6.2.4.9 When mild steel is used (see 6.6.2.1), calculation using the equation in 6.6.2.4.6 is not required.

6.6.2.4.10 There shall be no sudden change of plate thickness at the attachment of the ends (heads) to the cylindrical portion of the shell.

6.6.2.5 *Service equipment*

6.6.2.5.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. When the connection between the frame and the shell allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, shut-off devices), the internal stop-valve and its seating shall be protected against the danger of being wrenched off by external forces (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.6.2.5.2 All openings in the shell, intended for filling or discharging the portable tank shall be fitted with a manually operated stop-valve located as close to the shell as reasonably practicable. Other openings, except for openings leading to venting or pressure-relief devices, shall be equipped with either a stop-valve or another suitable means of closure located as close to the shell as reasonably practicable.

6.6.2.5.3 All portable tanks shall be fitted with a manhole or other inspection openings of a suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior. Compartmented portable tanks shall have a manhole or other inspection openings for each compartment.

6.6.2.5.4 As far as reasonably practicable, external fittings shall be grouped together. For insulated portable tanks, top fittings shall be surrounded by a spill collection reservoir with suitable drains.

6.6.2.5.5 Each connection to a portable tank shall be clearly marked to indicate its function.

6.6.2.5.6 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the shell taking into account the temperatures expected during transport. All stop-valves with screwed spindles shall close by a clockwise motion of the handwheel. For other stop-valves the position (open and closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed to prevent unintentional opening.

6.6.2.5.7 No moving parts, such as covers, components of closures, etc., shall be made of unprotected corrodible steel when they are liable to come into frictional or percussive contact with aluminium portable tanks intended for the transport of substances meeting the flash point criteria of Class 3 including elevated temperature substances transported above their flashpoint.

6.6.2.5.8 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of a suitable metallic material. Welded pipe joints shall be used wherever possible.

6.6.2.5.9 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525°C. The joints shall not decrease the strength of the tubing as may happen when cutting threads.

6.6.2.5.10 The burst pressure of all piping and pipe fittings shall be not less than the highest of four times the MAWP of the shell or four times the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief devices).

6.6.2.5.11 Ductile metals shall be used in the construction of valves and accessories.

6.6.2.6 *Bottom openings*

6.6.2.6.1 Certain substances shall not be transported in portable tanks with bottom openings. When the applicable portable tank instruction identified in Column 10 of the Dangerous Goods List and described in 4.2.4.2.6 indicates that bottom openings are prohibited there shall be no openings below the liquid level of the shell when it is filled to its maximum permissible filling limit. When an existing opening is closed it shall be accomplished by internally and externally welding one plate to the shell.

6.6.2.6.2 Bottom discharge outlets for portable tanks carrying certain solid, crystallizable or highly viscous substances shall be equipped with not less than two serially fitted and mutually independent shut-off devices. The design of the equipment shall be to the satisfaction of the competent authority or its authorized body and shall include:

(a) an external stop-valve fitted as close to the shell as reasonably practicable; and

(b) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

6.6.2.6.3 Every bottom discharge outlet, except as provided in 6.6.2.6.2, shall be equipped with three serially fitted and mutually independent shut-off devices. The design of the equipment shall be to the satisfaction of the competent authority or its authorized body and include:

(a) a self-closing internal stop-valve, that is a stop-valve within the shell or within a welded flange or its companion flange, such that:

(i) the control devices for the operation of the valve are designed so as to prevent any unintended opening through impact or other inadvertent act;

(ii) the valve may be operable from above or below;

(iii) if possible, the setting of the valve (open or closed) shall be capable of being verified from the ground;

(iv) except for portable tanks having a capacity of not more than 1,000 litres, it shall be possible to close the valve from an accessible position of the portable tank that is remote from the valve itself; and

(v) the valve shall continue to be effective in the event of damage to the external device for controlling the operation of the valve;

(b) an external stop-valve fitted as close to the shell as reasonably practicable; and

(c) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

6.6.2.6.4 For a lined shell, the internal stop-valve required by 6.6.2.6.3.1 may be replaced by an additional external stop-valve. The manufacturer shall satisfy the requirements of the competent authority or its authorized body.

6.6.2.7 *Safety relief devices*

6.6.2.7.1 All portable tanks shall be fitted with at least one pressure-relief device. All relief devices shall be designed, constructed and marked to the satisfaction of the competent authority or its authorized body.

6.6.2.8 *Pressure-relief devices*

6.6.2.8.1 Every portable tank with a capacity not less than 1,900 litres and every independent compartment of a portable tank with a similar capacity, shall be provided with one or more pressure-relief devices of the spring-loaded type and may in addition have a frangible disc or fusible element in parallel with the spring-loaded devices except when prohibited by reference to 6.6.2.8.3 in the applicable portable tank instruction in 4.2.4.2.6. The pressure-relief devices shall have sufficient capacity to prevent rupture of the shell due to over pressurization or vacuum resulting from filling, discharging, or from heating of the contents.

6.6.2.8.2 Pressure-relief devices shall be designed to prevent the entry of foreign matter, the leakage of liquid and the development of any dangerous excess pressure.

6.6.2.8.3 When required for certain substances by the applicable portable tank instruction identified in Column 10 of the Dangerous Goods List and described in 4.2.4.2.6, portable tanks shall have a pressure-relief device approved by the competent authority. Unless a portable tank in dedicated service is fitted with an approved relief device constructed of materials compatible with the load, the relief device shall comprise a

frangible disc preceding a spring-loaded pressure-relief device. When a frangible disc is inserted in series with the required pressure-relief device, the space between the frangible disc and the pressure-relief device shall be provided with a pressure gauge or suitable tell-tale indicator for the detection of disc rupture, pin holing, or leakage which could cause a malfunction of the pressure-relief system. The frangible disc shall rupture at a nominal pressure 10% above the start to discharge pressure of the relief device.

6.6.2.8.4 Every portable tank with a capacity less than 1,900 litres shall be fitted with a pressure-relief device which may be a frangible disc when this disc complies with the requirements of 6.6.2.11.1. When no spring-loaded pressure-relief device is used, the frangible disc shall be set to rupture at a nominal pressure equal to the test pressure.

6.6.2.8.5 When the shell is fitted for pressure discharge, the inlet line shall be provided with a suitable pressure-relief device set to operate at a pressure not higher than the MAWP of the shell, and a stop-valve shall be fitted as close to the shell as reasonably practicable.

6.6.2.9 *Setting of pressure-relief devices*

6.6.2.9.1 It shall be noted that the pressure-relief devices shall operate only in conditions of excessive rise in temperature, since the shell shall not be subject to undue fluctuations of pressure during normal conditions of transport (see 6.6.2.12.2).

6.6.2.9.2 The required pressure-relief device shall be set to start-to-discharge at a nominal pressure of five-sixths of the test pressure for shells having a test pressure of not more than 4.5 bar and 110% of two-thirds of the test pressure for shells having a test pressure of more than 4.5 bar. After discharge the device shall close at a pressure not more than 10 % below the pressure at which the discharge starts. The device shall remain closed at all lower pressures. This requirement does not prevent the use of vacuum-relief or combination pressure-relief and vacuum-relief devices.

6.6.2.10 *Fusible elements*

6.6.2.10.1 Fusible elements shall operate at a temperature between 110 °C and 149 °C on condition that the pressure in the shell at the fusing temperature will be not more than the test pressure. They shall be placed at the top of the shell with their inlets in the vapour space and in no case shall they be shielded from external heat. Fusible elements shall not be utilized on portable tanks with a test pressure which exceeds 2.65 bar. Fusible elements used on portable tanks intended for the transport of elevated temperature substances shall be designed to operate at a temperature higher than the maximum temperature that will be experienced during transport and shall be to the satisfaction of the competent authority or its authorized body.

6.6.2.11 *Frangible discs*

6.6.2.11.1 Except as specified in 6.6.2.8.3, frangible discs shall be set to rupture at a nominal pressure equal to the test pressure throughout the design temperature range. Particular attention shall be given to the requirements of 6.6.2.5.1 and 6.6.2.8.3 if frangible discs are used.

6.6.2.12 *Capacity of pressure-relief devices*

6.6.2.12.1 The spring-loaded pressure-relief device required by 6.6.2.8.1 shall have a minimum cross sectional flow area equivalent to an orifice of 31.75 mm diameter. Vacuum-relief devices, when used, shall have a cross sectional flow area not less than 284 mm^2.

6.6.2.12.2 The combined delivery capacity of the relief devices in condition of complete fire engulfment of the portable tank shall be sufficient to limit the pressure in the shell to 20% above the start-to-discharge pressure of the pressure limiting device. Emergency pressure-relief devices may be used to achieve the full relief capacity prescribed. Emergency pressure-relief devices may be of the spring-loaded, frangible or fusible type. The total required capacity of the relief devices may be determined using the formula in 6.6.2.12.2.1 or the table in 6.6.2.12.2.3.

6.6.2.12.2.1 To determine the total required capacity of the relief devices, which shall be regarded as being the sum of the individual capacities of all the contributing devices, the following formula shall be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC}\sqrt{\frac{ZT}{M}}$$

where:

Q = minimum required rate of discharge in cubic metres of air per second (m^3/s) at standard conditions: 1 bar and 0 °C (273 K);

F = is a coefficient with the following value:
for uninsulated shells $F = 1$
for insulated shells $F = U(649 - t)/13.6$ but in no case is less than 0.25
where:
U = thermal conductance of the insulation, in $kW \cdot m^{-2} K^{-1}$, at 38 °C
t = actual temperature of the substance during filling (in °C); when this temperature is unknown, let t = 15 °C:
The value of ***F*** given above for insulated shells may be taken provided that the insulation is in conformance with 6.6.2.12.2.4.

A = total external surface area of shell in square metres

Z = the gas compressibility factor in the accumulating condition (when this factor is unknown, let Z equal 1.0);

T = absolute temperature in Kelvin (°C + 273) above the pressure-relief devices in the accumulating condition;

L = the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M = molecular mass of the discharged gas;

C = a constant which is derived from one of the following formulae as a function of the ratio *k* of specific heats:

$$k = \frac{c_p}{c_v}$$

where

C_p is the specific heat at constant pressure; and

C_v is the specific heat at constant volume.

When $k > 1$:

$$C = \sqrt{k \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

When $k = 1$ or k is unknown:

$$C = \frac{1}{\sqrt{e}} = 0.607$$

where e is the mathematical constant 2.7183

C may also be taken from the following table:

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

6.6.2.12.2.2 As an alternative to the formula above, shells designed for the transport of liquids may have their relief devices sized in accordance with the table in 6.6.2.12.2.3. This table assumes an insulation value of $F = 1$ and shall be adjusted accordingly when the shell is insulated. Other values used in determining this table are:

M	=	86.7	T	=	394 K
L	=	334.94 kJ/kg	C	=	0.607
Z	=	1			

6.6.2.12.2.3 Minimum emergency vent capacity, Q, in cubic metres per air per second at 1 bar and 0 °C (273 K)

A Exposed area (square metres)	Q (Cubic metres of air per second)	A Exposed area (square metres)	Q (Cubic metres of air per second)
2	0.230	37.5	2.539
3	0.320	40	2.677
4	0.405	42.5	2.814
5	0.487	45	2.949
6	0.565	47.5	3.082
7	0.641	50	3.215
8	0.715	52.5	3.346
9	0.788	55	3.476
10	0.859	57.5	3.605
12	0.998	60	3.733
14	1.132	62.5	3.860
16	1.263	65	3.987
18	1.391	67.5	4.112
20	1.517	70	4.236
22.5	1.670	75	4.483
25	1.821	80	4.726
27.5	1.969	85	4.967
30	2.115	90	5.206
32.5	2.258	95	5.442
35	2.400	100	5.676

6.6.2.12.2.4 Insulation systems, used for the purpose of reducing venting capacity, shall be approved by the competent authority or its authorized body. In all cases, insulation systems approved for this purpose shall:

(a) remain effective at all temperatures up to 649 °C; and

(b) be jacketed with a material having a melting point of 700 °C or greater.

6.6.2.13 *Marking of pressure-relief devices*

6.6.2.13.1 Every pressure-relief device shall be plainly and permanently marked with the following:

(a) the pressure (in bar or kPa) or temperature (in °C) at which it is set to discharge;

(b) the allowable tolerance at the discharge pressure for spring-loaded devices;

(c) the reference temperature corresponding to the rated pressure for frangible discs;

(d) the allowable temperature tolerance for fusible elements; and

(e) the rated flow capacity of the device in standard cubic meters of air per second (m^3/s).

When practicable, the following information shall also be shown:

(f) the manufacturer's name and relevant catalogue number.

6.6.2.13.2 The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:1996.

6.6.2.14 *Connections to pressure-relief devices*

6.6.2.14.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except where duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always in use. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Vents or pipes from the pressure-relief device outlets, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving devices.

6.6.2.15 *Siting of pressure-relief devices*

6.6.2.15.1 Each pressure-relief device inlet shall be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure-relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure the escaping vapour is discharged unrestrictedly. For flammable substances, the escaping vapour shall be directed away from the shell in such a manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

6.6.2.15.2 Arrangements shall be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the portable tank overturning.

6.6.2.16 *Gauging devices*

6.6.2.16.1 Glass level-gauges and gauges made of other fragile material, which are in direct communication with the contents of the tank shall not be used.

6.6.2.17 Portable tank supports, frameworks, lifting and tie-down attachments

6.6.2.17.1 Portable tanks shall be designed and constructed with a support structure to provide a secure base during transport. The forces specified in 6.6.2.2.12 and the safety factor specified in 6.6.2.2.13 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.2.17.2 The combined stresses caused by portable tank mountings (e.g. cradles, framework, etc.) and portable tank lifting and tie-down attachments shall not cause excessive stress in any portion of the shell. Permanent lifting and tie-down attachments shall be fitted to all portable tanks. Preferably they shall be fitted to the portable tank supports but may be secured to reinforcing plates located on the shell at the points of support.

6.6.2.17.3 In the design of supports and frameworks the effects of environmental corrosion shall be taken into account.

6.6.2.17.4 Forklift pockets shall be capable of being closed off. The means of closing forklift pockets shall be a permanent part of the framework or permanently attached to the framework. Single compartment portable tanks with a length less than 3.65 m need not have closed off forklift pockets provided that:

(a) the shell including all the fittings are well protected from being hit by the forklift blades; and

(b) the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.6.2.17.5 When portable tanks are not protected during transport, according to 4.2.1.2, the shells and service equipment shall be protected against damage to the shell and service equipment resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;

(b) protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact which may consist of a bumper or frame;

(d) protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995.

6.6.2.18 *Design approval*

6.6.2.18.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter and where appropriate, the provisions for substances provided in Chapter 4.2 and in the Dangerous Goods List in Chapter 3.2. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the substances or group of substances allowed to be transported, the materials of construction of the shell and lining (when applicable) and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Any alternative arrangements according to 6.6.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.6.2.18.2 The prototype test report for the design approval shall include at least the following:

(a) the results of the applicable framework test specified in ISO 1496-3:1995;

(b) the results of the initial inspection and test in 6.6.2.19.3; and

(c) the results of the impact test in 6.6.2.19.1, when applicable.

6.6.2.19 *Inspection and testing*

6.6.2.19.1 For portable tanks meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype portable tank shall be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4 g) the MPGM of the fully loaded portable tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads,
Manual of Standards and Recommended Practices,
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6.6.2.19.2 The shell and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the date of the last periodic inspection and test when necessary according to 6.6.2.19.7.

6.6.2.19.3 The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank and its fittings with due regard to the substances to be transported, and a pressure test. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the shell and its fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

6.6.2.19.4 The 5-year periodic inspection and test shall include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. When the shell and equipment have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

6.6.2.19.5 The intermediate 2.5 year periodic inspection and test shall at least include an internal and external examination of the portable tank and its fittings with due regard to the substances intended to be transported, a leakproofness test and a test of the satisfactory operation of all service equipment. Sheathing, thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. For portable tanks dedicated to the transport of a single substance, the 2.5 year internal examination may be waived or substituted by other test methods or inspection procedures by the competent authority or its authorized body.

6.6.2.19.6 A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 6.6.2.19.2. However a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

(a) after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

(b) unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.6.2.19.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.6.2.19.5.

6.6.2.19.8 The internal and external examinations shall ensure that:

(a) the shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the shell unsafe for transport;

(b) the piping, valves, heating/cooling system, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or transport;

(c) devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;

(d) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

(e) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;

(f) linings, if any, are inspected in accordance with criteria outlined by the lining manufacturer;

(g) required markings on the portable tank are legible and in accordance with the applicable requirements; and

(h) the framework, supports and arrangements for lifting the portable tank are in a satisfactory condition.

6.6.2.19.9 The inspections and tests in 6.6.2.19.1, 6.6.2.19.3, 6.6.2.19.4, 6.6.2.19.5 and 6.6.2.19.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.

6.6.2.19.10 In all cases when cutting, burning or welding operations on the shell have been effected, that work shall be to the approval of the competent authority or its authorized body taking into account the pressure vessel code used for the construction of the shell. A pressure test to the original test pressure shall be performed after the work is completed.

6.6.2.19.10 When evidence of any unsafe condition is discovered, the portable tank shall not be returned to service until it has been corrected and the test is repeated and passed.

6.6.2.20 *Marking*

6.6.2.20.1 Every portable tank shall be fitted with a corrosion resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When for reasons of portable tank arrangements the plate cannot be permanently attached to the shell, the shell shall be marked with at least the information required by the pressure vessel code. As a minimum at least the following information shall be marked on the plate by stamping or by any other similar method.

Country of manufacture:

U	Approval	Approval	For Alternative	Arrangements
N	Country	Number		"AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure vessel code to which the shell is designed

Test pressure _____ bar/kPa gauge */

MAWP _____ bar/kPa gauge */

External design pressure **/ _____ bar/kPa gauge */

Design temperature range _____ °C to _____ °C.

Water capacity at 20 °C _____ litres

Water capacity of each compartment at 20 °C_____ litres

Initial pressure test date and witness identification

MAWP for heating/cooling system _____ bar/kPa gauge */

Shell material(s) and material standard reference(s)

Equivalent thickness in reference steel _____ mm

Lining material (when applicable)

Date and type of most recent periodic test(s)

Month_____ Year_____ Test pressure_____bar/kPa gauge */

Stamp of expert who performed or witnessed the most recent test

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*/ *The unit used shall be marked.*

**/ *See 6.6.2.2.10.*

6.6.2.20.2 The following information shall be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank:

Name of the operator

Name of substance(s) being transported and maximum mean bulk temperature when higher than 50°C

Maximum permissible gross mass (MPGM) _____ kg

Unladen (tare) mass_____ kg

***NOTE**: For the indentification of the substances being transported, see also Part 5.*

6.6.3 Requirements for the design, construction, inspection and testing of portable tanks intended for the transport of non-refrigerated liquefied gases

6.6.3.1 *Definitions*

For the purposes of this section:

Portable tank means a multimodal tank having a capacity of more than 450 litres used for the transport of non-refrigerated liquefied gases of Class 2. The portable tank includes a shell fitted with service equipment and structural equipment necessary for the transport of gases. The portable tank shall be capable of being loaded and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the shell, and shall be capable of being lifted when full. It shall be designed primarily to be loaded onto a transport vehicle or ship and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs), gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

Shell means the part of the portable tank which retains the non-refrigerated liquefied gas intended for transport (tank proper), including openings and their closures, but does not include service equipment or structural equipment;

Service equipment means measuring instruments and filling, discharge, venting, safety and insulating devices;

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the shell;

Maximum allowable working pressure (MAWP) means a pressure that shall be not less than the highest of the following pressures measured at the top of the shell while in operating position, but in no case less than 7 bar:

(a) the maximum effective gauge pressure allowed in the shell during filling or discharge; or

(b) the maximum effective gauge pressure to which the shell is designed, which shall be:

(i) for a non-refrigerated liquefied gas listed in the portable tank instruction T50 in 4.2.4.2.6, the MAWP (in bar) given in T50 portable tank instruction for that gas;

(ii) for other non-refrigerated liquefied gases, not less than the sum of:

- the absolute vapour pressure (in bar) of the non-refrigerated liquefied gas at the design reference temperature minus 1 bar; and

- the partial pressure (in bar) of air or other gases in the ullage space being determined by the design reference temperature and the liquid phase expansion due to the increase of the mean bulk temperature of t_r-t_f (t_f = filling temperature, usually 15°C, t_r = 50 °C maximum mean bulk temperature).

Design pressure means the pressure to be used in calculations required by a recognized pressure vessel code. The design pressure shall be not less than the highest of the following pressures:

(a) the maximum effective gauge pressure allowed in the shell during filling or discharge; or

(b) the sum of:

(i) the maximum effective gauge pressure to which the shell is designed as defined in (b) of the MAWP definition (see above); and

(ii) a head pressure determined on the basis of the dynamic forces specified in 6.6.2.3.2.9, but not less than 0.35 bar;

Test pressure means the maximum gauge pressure at the top of the shell during the pressure test;

Leakproofness test means a test using gas subjecting the shell and its service equipment to an effective internal pressure of not less than 25% of the MAWP;

Maximum permissible gross mass (MPGM) means the sum of the tare mass of the portable tank and the heaviest load authorized for transport;

Reference steel means a steel with a tensile strength of 370 N/mm^2 and an elongation at fracture of 27%;

Mild steel means a steel with a guaranteed minimum tensile strength of 360 N/mm^2 to 440 N/mm^2 and a guaranteed minimum elongation at fracture conforming to 6.6.3.3.3.3;

Design temperature range for the shell shall be -40 °C to 50 °C for non-refrigerated liquefied gases transported under ambient conditions. More severe design temperatures shall be considered for portable tanks subjected to severe climatic conditions;

Design reference temperature means the temperature at which the vapour pressure of the contents is determined for the purpose of calculating the MAWP. The design reference temperature shall be less than the critical temperature of the non-refrigerated liquefied gas intended to be transported to ensure that the gas at all times is liquefied. This value for each portable tank type is as follows:

(a) shell with a diameter of 1.5 metres or less: 65 °C;

(b) shell with a diameter of more than 1.5 metres:

(i) without insulation or sun shield: 60 °C;

(ii) with sun shield (see 6.6.3.2.12): 55 °C; and

(iii) with insulation (see 6.6.3.2.12) : 50 °C;

Filling density means the average mass of non-refrigerated liquefied gas per litre of shell capacity (kg/l). The filling density is given in portable tank instruction T50 in 4.2.4.2.6.

6.6.3.2 *General design and construction requirements*

6.6.3.2.1 Shells shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. Shells shall be made of steel suitable for forming. The materials shall in principle conform to national or international material standards. For welded shells, only a material whose weldability has been fully demonstrated shall be used. Welds shall be skilfully made and afford complete safety. When the manufacturing process or the materials make it necessary, the shells shall be suitability heat-treated to guarantee adequate toughness in the weld and in the heat affected zones. In choosing the material the design temperature range shall be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. When fine grain steel is used, the guaranteed value of the yield strength shall be not more than 460 N/mm^2 and the guaranteed value of the upper limit of the tensile strength shall be not more than 725 N/mm^2 according to the material specification. Portable tank materials shall be suitable for the external environment in which they may be transported.

6.6.3.2.2 Portable tank shells, fittings and pipework shall be constructed of materials which are:

(a) substantially immune to attack by the non-refrigerated liquefied gas(es) intended to be transported; or

(b) properly passivated or neutralized by chemical reaction.

6.6.3.2.3 Gaskets shall be made of materials compatible with the non-refrigerated liquefied gas(es) intended to be transported.

6.6.3.2.4 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.

6.6.3.2.5 The materials of the portable tank, including any devices, gaskets, and accessories, shall not adversely affect the non-refrigerated liquefied gases intended for transport in the portable tank.

6.6.3.2.6 Portable tanks shall be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

6.6.3.2.7 Portable tanks shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and transport. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the portable tank, have been taken into account.

6.6.3.2.8 Shells shall be designed to withstand an external pressure of at least 0.4 bar gauge above the internal pressure without permanent deformation. When the shell is to be subjected to a significant vacuum before filling or during discharge it shall be designed to withstand an external pressure of at least 0.9 bar gauge above the internal pressure and shall be proven at that pressure.

6.6.3.2.9 Portable tanks and their fastenings shall, under the maximum permissible load, be capable of absorbing the following separately applied static forces:

(a) in the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)*/;

(b) horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g)*/;

(c) vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)*/; and

(d) vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)*/.

6.6.3.2.10 Under each of the forces in 6.6.3.2.9, the safety factor to be observed shall be as follows:

(a) for steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or

(b) for steels with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof strength and, for austenitic steels, the 1% proof strength.

6.6.3.2.11 The values of yield strength or proof strength shall be the value according to national or international material standards. When austenitic steels are used, the specified minimum values of yield strength and proof strength according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the value of yield strength or proof strength used shall be approved by the competent authority.

6.6.3.2.12 When the shells intended for the transport of non-refrigerated liquefied gases are equipped with thermal insulation, the thermal insulation systems shall satisfy the following requirements:

(a) It shall consist of a shield covering not less than the upper third but not more than the upper half of the surface of the shell and separated from the shell by an air space about 40 mm across; or

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*/ *For calculation purposes* $g = 9.81\ m/s^2$

(b) It shall consist of a complete cladding of adequate thickness of insulating materials protected so as to prevent the ingress of moisture and damage under normal conditions of transport and so as to provide a thermal conductance of not more than 0.67 ($W.m^{-2}.K^{-1}$);

(c) When the protective covering is so closed as to be gas-tight, a device shall be provided to prevent any dangerous pressure from developing in the insulating layer in the event of inadequate gas tightness of the shell or of its items of equipment;

(d) The thermal insulation shall not inhibit access to the fittings and discharge devices.

6.6.3.2.13 Portable tanks intended for the transport of flammable non-refrigerated liquefied gases shall be capable of being electrically earthed.

6.6.3.3. *Design criteria*

6.6.3.3.1 Shells shall be of a circular cross-section.

6.6.3.3.2 Shells shall be designed and constructed to withstand a test pressure not less than 1.3 times the design pressure. The shell design shall take into account the minimum MAWP values provided in portable tank instruction T50 in 4.2.4.2.6 for each non-refrigerated liquefied gas intended for transport. Attention is drawn to the minimum shell thickness requirements for these shells specified in 6.6.3.4.

6.6.3.3.3 For steels exhibiting a clearly defined yield point or characterized by a guaranteed proof strength (0.2% proof strength, generally, or 1% proof strength for austenitic steels) the primary membrane stress σ (sigma) in the shell shall not exceed 0.75 Re or 0.50 Rm, whichever is lower, at the test pressure, where:

Re = yield strength in N/mm^2, or 0.2% proof strength or, for austenitic steels, 1% proof strength.

Rm = minimum tensile strength in N/mm^2.

6.6.3.3.3.1 The values of Re and Rm to be used shall be the specified minimum values according to national or international material standards. When austenitic steels are used, the specified minimum values for Re and Rm according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body.

6.6.3.3.3.2 Steels which have a Re/Rm ratio of more than 0.85 are not allowed for the construction of welded shells. The values of Re and Rm to be used in determining this ratio shall be the values specified in the material inspection certificate.

6.6.3.3.3.3 Steels used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/Rm with an absolute minimum of 16% for fine grain steels and 20% for other steels.

6.6.3.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1984 using a 50 mm gauge length.

6.6.3.4 *Minimum shell thickness*

6.6.3.4.1 The minimum shell thickness shall be the greater thickness based on:

(a) the minimum thickness determined in accordance with the requirements in 6.6.3.4; and

(b) the minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.6.3.3.

6.6.3.4.2 The cylindrical portions, ends (heads) and manhole covers of shells of not more than 1.80 m in diameter shall be not less than 5 mm thick in the reference steel or of equivalent thickness in the steel to be used. Shells of more than 1.80 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the steel to be used.

6.6.3.4.3 The cylindrical portions, ends (heads) and manhole covers of all shells shall be not less than 4 mm thick regardless of the material of construction.

6.6.3.4.4 The equivalent thickness of a steel other than the thickness prescribed for the reference steel in 6.6.3.4.2 shall be determined using the following formula:

$$e_1 = \frac{21.4 e_o}{\sqrt[3]{Rm_1 \times A_1}}$$

where:

e_1 = required equivalent thickness (in mm) of the steel to be used;
e_o = minimum thickness (in mm) for the reference steel specified in 6.6.3.4.2;
Rm_1 = guaranteed minimum tensile strength (in N/mm^2) of the steel to be used (see 6.6.3.3.3);
A_1 = guaranteed minimum elongation at fracture (in %) of the steel to be used according to national or international standards.

6.6.3.4.5 In no case shall the wall thickness be less than that prescribed in 6.6.3.4.1 to 6.6.3.4.3. All parts of the shell shall have a minimum thickness as determined by 6.6.3.4.1 to 6.6.3.4.3. This thickness shall be exclusive of any corrosion allowance.

6.6.3.4.6 When mild steel is used (see 6.6.3.1), calculation using the equation in 6.6.3.4.4 is not required.

6.6.3.4.7 There shall be no sudden change of plate thickness at the attachment of the ends (heads) to the cylindrical portion of the shell.

6.6.3.5 *Service equipment*

6.6.3.5.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. When the connection between the frame and the shell allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, shut-off devices), the internal stop-valve and its seating shall be protected against the danger of being wrenched off by external forces (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.6.3.5.2 All openings with a diameter of more than 1.5 mm in shells of portable tanks, except openings for pressure-relief devices, inspection openings and closed bleed holes, shall be fitted with at least three mutually independent shut-off devices in series, the first being an internal stop-valve, excess flow valve or equivalent device, the second being an external stop-valve and the third being a blank flange or equivalent device.

6.6.3.5.2.1 When a portable tank is fitted with an excess flow valve the excess flow valve shall be so fitted that its seating is inside the shell or inside a welded flange or, when fitted externally, its mountings shall be designed so that in the event of impact its effectiveness shall be maintained. The excess flow valves shall be selected and fitted so as to close automatically when the rated flow specified by the manufacturer is reached. Connections and accessories leading to or from such a valve shall have a capacity for a flow more than the rated flow of the excess flow valve.

6.6.3.5.3 For filling and discharge openings the first shut-off device shall be an internal stop-valve and the second shall be a stop-valve placed in an accessible position on each discharge and filling pipe.

6.6.3.5.4 For filling and discharge bottom openings of portable tanks intended for the transport of flammable and/or toxic non-refrigerated liquefied gases the internal stop-valve shall be a quick closing safety device which closes automatically in the event of unintended movement of the portable tank during filling or discharge or fire engulfment. Except for portable tanks having a capacity of not more than 1 000 litres, it shall be possible to operate this device by remote control.

6.6.3.5.5 In addition to filling, discharge and gas pressure equalizing orifices, shells may have openings in which gauges, thermometers and manometers can be fitted. Connections for such instruments shall be made by suitable welded nozzles or pockets and not be screwed connections through the shell.

6.6.3.5.6 All portable tanks shall be fitted with manholes or other inspection openings of suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior.

6.6.3.5.7 External fittings shall be grouped together so far as reasonably practicable.

6.6.3.5.8 Each connection on a portable tank shall be clearly marked to indicate its function.

6.6.3.5.9 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the shell taking into account the temperatures expected during transport. All stop-valves with screwed spindles shall close by a clockwise motion of the handwheel. For other stop-valves the position (open or closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed to prevent unintentional opening.

6.6.3.5.10 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of suitable metallic material. Welded pipe joints shall be used wherever possible.

6.6.3.5.11 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525 °C. The joints shall not decrease the strength of tubing as may happen when cutting threads.

6.6.3.5.12 The burst pressure of all piping and pipe fittings shall be not less than the lightest of four times the MAWP of the shell or four times the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief devices).

6.6.3.5.13 Ductile metals shall be used in the construction of valves or accessories.

6.6.3.6 *Bottom openings*

6.6.3.6.1 Certain non-refrigerated liquefied gases shall not be transported in portable tanks with bottom openings when portable tank instruction T50 in 4.2.4.2.6 indicates that bottom openings are not allowed. There shall be no openings below the liquid level of the shell when it is filled to its maximum permissible filling limit.

6.6.3.7 *Pressure-relief devices*

6.6.3.7.1 Portable tanks shall be provided with one or more spring-loaded pressure-relief devices. The pressure-relief devices shall open automatically at a pressure not less than the MAWP and be fully open at a pressure equal to 110% of the MAWP. These devices shall, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts and shall remain closed at all lower pressures. The pressure-relief devices shall be of a type that will resist dynamic forces including liquid surge. Frangible discs not in series with a spring-loaded pressure-relief device are not permitted.

6.6.3.7.2 Pressure-relief devices shall be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.

6.6.3.7.3 Portable tanks intended for the transport of certain non-refrigerated liquefied gases identified in portable tank instruction T50 in 4.2.4.2.6 shall have a pressure-relief device approved by the competent authority. Unless a portable tank in dedicated service is fitted with an approved relief device constructed of materials compatible with the load, such device shall comprise a frangible disc preceding a spring-loaded device. The space between the frangible disc and the device shall be provided with a pressure gauge or a suitable tell-tale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the pressure-relief device. The frangible discs shall rupture at a nominal pressure 10% above the start-to-discharge pressure of the relief device.

6.6.3.7.4 In the case of multi-purpose portable tanks, the pressure-relief devices shall open at a pressure indicated in 6.6.3.7.1 for the gas having the highest maximum allowable pressure of the gases allowed to be transported in the portable tank.

6.6.3.8 *Capacity of relief devices*

6.6.3.8.1 The combined delivery capacity of the relief devices shall be sufficient that, in the event of total fire engulfment, the pressure (including accumulation) inside the shell does not exceed 120% of the MAWP. Spring-loaded relief devices shall be used to achieve the full relief capacity prescribed. In the case of multi-purpose tanks, the combined delivery capacity of the pressure-relief devices shall be taken for the gas which requires the highest delivery capacity of the gases allowed to be transported in portable tanks.

6.6.3.8.1.1 To determine the total required capacity of the relief devices, which shall be regarded as being the sum of the individual capacities of the several devices, the following formulae */ shall be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC}\sqrt{\frac{ZT}{M}}$$

where:

Q = minimum required rate of discharge in cubic metres of air per second (m^3/s) at standard conditions. 1 bar and 0°C (273 K);

F = is a coefficient with the following value:
for uninsulated shells $F=1$
for insulated shells $F=U(649-t)/13.6$ but in no case is less than 0.25 where:
U = thermal conductance of the insulation, in $kW.m^{-2}.K^{-1}$, at 38°C,
t = actual temperature of the non-refrigerated liquefied gas during filling(°C); when this temperature is unknown, let $t=15$°C.
The value of ***F*** given above for insulated shells may be taken provided that the insulation is in conformance with 6.6.3.8.1.2.

A = total external surface area of shell in square metres;

Z = the gas compressibility factor in the accumulating condition (when this factor is unknown, let ***Z*** equal 1.0);

T = absolute temperature in Kelvin (°C + 273) above the pressure-relief devices in the accumulating condition;

L = the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M = molecular mass of the discharged gas;

C = a constant which may be taken from the following table which is derived from the following equation as a function of the ratio k of specific heats

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*/ *This formula applies only to non-refrigerated liquefied gases which have critical temperatures well above the temperature at the accumulating condition. For gases which have critical temperatures near or below the temperature at the accumulating condition, the calculation of the pressure-relief device delivery capacity shall consider further thermodynamic properties of the gas (see for example CGA S-1.2-1995).*

C = 0.607 when k is equal to or less than 1; or

$$C = \sqrt{k \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

when k is greater than 1

where $k = C_p/C_v$

C_p = the specific heat at constant pressure and
C_v = the specific heat at constant volume;

Alternatively C may be taken from the following table:

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

6.6.3.8.1.2 Insulation systems, used for the purpose of reducing the venting capacity, shall be approved by the competent authority or its authorized body. In all cases, insulation systems approved for this purpose shall:

(a) remain effective at all temperatures up to 649°C; and

(b) be jacketed with a material having a melting point of 700°C or greater.

6.6.3.9 *Marking of pressure-relief devices*

6.6.3.9.1 Every pressure-relief device shall be plainly and permanently marked with the following:

(a) the pressure (in bar or kPa) at which it is set to discharge;

(b) the allowable tolerance at the discharge pressure for spring-loaded devices;

(c) the reference temperature corresponding to the rated pressure for frangible discs; and

(d) the rated flow capacity of the device in standard cubic metres of air per second (m^3/s).

When practicable, the following information shall also be shown:

(e) the manufacturer's name and relevant catalogue number.

6.6.3.9.2 The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:1996.

6.6.3.10 *Connections to pressure-relief devices*

6.6.3.10.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except when duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always operable and capable of meeting the requirements of 6.6.3.8. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Vents from the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

6.6.3.11 *Siting of pressure-relief devices*

6.6.3.11.1 Each pressure-relief device inlet shall be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure that the escaping vapour is discharged unrestrictedly. For flammable non-refrigerated liquefied gases, the escaping vapour shall be directed away from the shell in such a manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

6.6.3.11.2 Arrangements shall be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the portable tank overturning.

6.6.3.12 *Gauging devices*

6.6.3.12.1 Unless a portable tank is intended to be filled by weight it shall be equipped with one or more gauging devices. Glass level-gauges and gauges made of other fragile material, which are in direct communication with the contents of the shell shall not be used.

6.6.3.13 *Portable tank supports, frameworks, lifting and tie-down attachments*

6.6.3.13.1 Portable tanks shall be designed and fabricated with a support structure to provide a secure base during transport. The forces specified in 6.6.3.2.9 and the safety factor specified in 6.6.3.2.10 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.3.13.2 The combined stresses caused by portable tank mountings (e.g. cradles, frameworks, etc.) and portable tank lifting and tie-down attachments shall not cause excessive stress in any portion of the shell. Permanent lifting and tie-down attachments shall be fitted to all portable tanks. Preferably they shall be fitted to the portable tank supports but may be secured to reinforcing plates located on the shell at the points of support.

6.6.3.13.3 In the design of supports and frameworks the effects of environmental corrosion shall be taken into account.

6.6.3.13.4 Forklift pockets shall be capable of being closed off. The means of closing forklift pockets shall be a permanent part of the framework or permanently attached to the framework. Single compartment portable tanks with a length less than 3.65 m need not have closed off forklift pockets provided that:

(a) the shell and all the fittings are well protected from being hit by the forklift blades; and

(b) the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.6.3.13.5 When portable tanks are not protected during transport, according to 4.2.2.3, the shells and service equipment shall be protected against damage to the shell and service equipment resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;

(b) protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact which may consist of a bumper or frame;

(d) protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995.

6.6.3.14 *Design approval*

6.6.3.14.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that the portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter and when appropriate the provisions for gases provided in portable tank instruction T50 in 4.2.4.2.6. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the gases allowed to be transported, the materials of construction of the shell and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Any alternative arrangements according to 6.6.1.2 shall be indicated on the certificate.

A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.6.3.14.2 The prototype test report for the design approval shall include at least the following:

(a) the results of the applicable framework test specified in ISO 1496-3:1995;

(b) the results of the initial inspection and test in 6.6.3.15.3; and

(c) the results of the impact test in 6.6.3.15.1, when applicable.

6.6.3.15 *Inspection and testing*

6.6.3.15.1 For portable tanks meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype portable tank shall be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4 g) the MPGM of the fully loaded portable tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads,
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600), 1992

Canadian Standards Association (CSA),
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods
(B620-1987)

Deutsche Bahn AG
Zentralbereich Technik, Minden
Portable tanks, longitudinal dynamic impact test

Société Nationale des Chemins de Fer Français
C.N.E.S.T. 002-1966.
Tank containers, longitudinal external stresses and dynamic impact tests

Spoornet, South Africa
Engineering Development Centre (EDC)
Testing of ISO Tank Containers
Method EDC/TES/023/000/1991-06

6.6.3.15.2 The shell and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.6.3.15.7.

6.6.3.15.3 The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank and its fittings with due regard to the non-refrigerated liquefied gases to be transported, and a pressure test referring to the test pressures according to 6.6.3.3.2. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the shell and its fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test. All welds subject to full stress level in the shell shall be inspected during the initial test by radiographic, ultrasonic, or another suitable non-destructive test method. This does not apply to the jacket.

6.6.3.15.4 The 5 year periodic inspection and test shall include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. When the shell and equipment have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

6.6.3.15.5 The intermediate 2.5 year periodic inspection and test shall at least include an internal and external examination of the portable tank and its fittings with due regard to the non-refrigerated liquefied gases intended to be transported, a leakproofness test and a test of the satisfactory operation of all service equipment. Sheathing thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. For portable tanks intended for the transport of a single non-refrigerated liquefied gas, the 2.5 year internal examination may be waived or substituted by other test methods or inspection procedures specified by the competent authority or its authorized body.

6.6.3.15.6 A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 6.6.3.15.2. However a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

(a) after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

(b) unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.6.3.15.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.6.3.15.5.

6.6.3.15.8 The internal and external examinations shall ensure that:

(a) the shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the portable tank unsafe for transport;

(b) the piping, valves, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or transport;

(c) devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;

(d) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

(e) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;

(f) required markings on the portable tank are legible and in accordance with the applicable requirements; and

(g) the framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.

6.6.3.15.9 The inspections and tests in 6.6.3.15.1, 6.6.3.15.3, 6.6.3.15.4, 6.6.3.15.5 and 6.6.3.15.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.

6.6.3.15.10 In all cases when cutting, burning or welding operations on the shell have been effected, that work shall be to the approval of the competent authority or its authorized body taking into account the pressure vessel code used for the construction of the shell. A pressure test to the original test pressure shall be performed after the work is completed.

6.6.3.15.11 When evidence of any unsafe condition is discovered, the portable tank shall not be returned to service until it has been corrected and the pressure test is repeated and passed.

6.6.3.16 *Marking*

6.6.3.16.1 Every portable tank shall be fitted with a corrosion resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When for reasons of portable tank arrangements, the plate cannot be permanently attached to the shell, the shell shall be marked with at least the information required by the pressure vessel code. As a minimum at least the following information shall be marked on the plate by stamping or by any other similar method.

Country of manufacture

U N	Approval Country	Approval Number	For Alternative Arrangements "AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure vessel code to which the shell is designed

Test pressure _____bar/kPa gauge*/

MAWP_____ bar/kPa gauge */

External design pressure **/ _____ bar/kPa gauge */

Design temperature range_____ °C to_____ °C

Design reference temperature_____ °C

Water capacity at 20°C _____litres

Initial pressure test date and witness identification

Shell material(s) and material standard reference(s)

Equivalent thickness in reference steel _____mm

Date and type of most recent periodic test(s)

Month_____ Year_____ Test pressure_____bar/kPa gauge */

Stamp of expert who performed or witnessed the most recent test

6.6.3.16.2 The following information shall be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank:

Name of the operator

Name of non-refrigerated liquefied gas(es) permitted for transport

Maximum permissible load mass for each non-refrigerated liquefied gas permitted _____kg

Maximum permissible gross mass (MPGM)_____kg

Unladen (tare) mass_____kg

***NOTE**: For the identification of the non-refrigerated liquefied gases being transported, see also Part 5.*

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*/ *The unit used shall be marked.*

**/ *See 6.6.3.2.8.*

6.6.4 Requirements for the design, construction, inspection and testing of portable tanks intended for the transport of refrigerated liquefied gases

6.6.4.1 *Definitions*

For the purposes of this section:

Portable tank means a thermally insulated multimodal tank having a capacity of more than 450 litres fitted with service equipment and structural equipment necessary for the transport of refrigerated liquefied gases. The portable tank shall be capable of being loaded and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the tank, and shall be capable of being lifted when full. It shall be designed primarily to be loaded onto a transport vehicle or ship and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs), gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

Tank means a construction which normally consists of either :

(a) a jacket and one or more inner shells where the space between the shell(s) and the jacket is exhausted of air (vacuum insulation) and may incorporate a thermal insulation system; or

(b) a jacket and an inner shell with an intermediate layer of solid thermally insulating material (e.g. solid foam);

Shell means the part of the portable tank which retains the refrigerated liquefied gas intended for transport, including openings and their closures, but does not include service equipment or external structural equipment;

Jacket means the outer insulation cover or cladding which may be part of the insulation system;

Service equipment means measuring instruments and filling, discharge, venting, safety, pressurizing, cooling and thermal insulation devices;

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the shell;

Maximum allowable working pressure (MAWP) means the maximum effective gauge pressure permissible at the top of the shell of a loaded portable tank in its operating position including the highest effective pressure during filling and discharge;

Test pressure means the maximum gauge pressure at the top of the shell during the pressure test;

Leakproofness test means a test using gas subjecting the shell and its service equipment, to an effective internal pressure not less than 90 % of the MAWP;

Maximum permissible gross mass (MPGM) means the sum of the tare mass of the portable tank and the heaviest load authorized for transport;

Holding time means the time that will elapse from the establishment of the initial filling condition until the pressure has risen due to heat influx to the lowest set pressure of the pressure limiting device(s);

Reference steel means a steel with a tensile strength of 370 N/mm^2 and an elongation at fracture of 27 %;

Minimum design temperature means the temperature which is used for the design and construction of the shell not higher than the lowest (coldest) temperature (service temperature) of the contents during normal conditions of filling, discharge and transport.

6.6.4.2 *General design and construction requirements*

6.6.4.2.1 Shells shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. Shells and jackets shall be made of metallic materials suitable for forming. Jackets shall be made of steel. Non-metallic materials may be used for the attachments and supports between the shell and jacket, provided their material properties at the minimum design temperature are proven to be sufficient. The materials shall in principle conform to national or international material standards. For welded shells and jackets only materials whose weldability has been fully demonstrated shall be used. Welds shall be skilfully made and afford complete safety. When the manufacturing process or the materials make it necessary, the shell shall be suitably heat treated to guarantee adequate toughness in the weld and in the heat affected zones. In choosing the material, the minimum design temperature shall be taken into account with respect to risk of brittle fracture, to hydrogen embrittlement, to stress corrosion cracking and to resistance to impact. When fine grain steel is used, the guaranteed value of the yield strength shall be not more than 460 N/mm^2 and the guaranteed value of the upper limit of the tensile strength shall be not more than 725 N/mm^2 in accordance with the material specifications. Portable tank materials shall be suitable for the external environment in which they may be transported.

6.6.4.2.2 Any part of a portable tank, including fittings, gaskets and pipe-work, which can be expected normally to come into contact with the refrigerated liquefied gas transported shall be compatible with that refrigerated liquefied gas.

6.6.4.2.3 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.

6.6.4.2.4 The thermal insulation system shall include a complete covering of the shell(s) with effective insulating materials. External insulation shall be protected by a jacket so as to prevent the ingress of moisture and other damage under normal transport conditions.

6.6.4.2.5 When a jacket is so closed as to be gas-tight, a device shall be provided to prevent any dangerous pressure from developing in the insulation space.

6.6.4.2.6 Portable tanks intended for the transport of refrigerated liquefied gases having a boiling point below minus 182 °C at atmospheric pressure shall not include materials which may react with oxygen or oxygen enriched atmospheres in a dangerous manner, when located in parts of the thermal insulation when there is a risk of contact with oxygen or with oxygen enriched fluid.

6.6.4.2.7 Insulating materials shall not deteriorate unduly in service.

6.6.4.2.8 A reference holding time shall be determined for each refrigerated liquefied gas intended for transport in a portable tank.

6.6.4.2.8.1 The reference holding time shall be determined by a method recognized by the competent authority on the basis of the following:

(a) the effectiveness of the insulation system, determined in accordance with 6.6.4.2.8.2;

(b) the lowest set pressure of the pressure limiting device(s);

(c) the initial filling conditions;

(d) an assumed ambient temperature of 30°C;

(e) the physical properties of the individual refrigerated liquefied gas intended to be transported.

6.6.4.2.8.2 The effectiveness of the insulation system (heat influx in watts) shall be determined by type testing the portable tank in accordance with a procedure recognized by the competent authority. This test shall consist of either:

(a) a constant pressure test (for example at atmospheric pressure) when the loss of refrigerated liquefied gas is measured over a period of time; or

(b) a closed system test when the rise in pressure in the shell is measured over a period of time.

When performing the constant pressure test, variations in atmospheric pressure shall be taken into account. When performing either tests corrections shall be made for any variation of the ambient temperature from the assumed ambient temperature reference value of 30°C.

***NOTE**: For the determination of the actual holding time before each journey, refer to 4.2.3.7.*

6.6.4.2.9 The jacket of a vacuum-insulated double-wall tank shall have either an external design pressure not less than 100 kPa (1 bar) gauge pressure calculated in accordance with a recognized technical code or a calculated critical collapsing pressure of not less than 200 kPa (2 bar) gauge pressure. Internal and external reinforcements may be included in calculating the ability of the jacket to resist the external pressure.

6.6.4.2.10 Portable tanks shall be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

6.6.4.2.11 Portable tanks shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and transport. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the portable tank, have been taken into account.

6.6.4.2.12 Portable tanks and their fastenings under the maximum permissible load shall be capable of absorbing the following separately applied static forces:

(a) in the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)*/;

(b) horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g)*/;

(c) vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)*/; and

(d) vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)*/.

6.6.4.2.13 Under each of the forces in 6.6.4.2.12, the safety factor to be observed shall be as follows:

(a) for materials having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or

(b) for materials with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2 % proof strength or, in case of austenitic steels, the 1 % proof strength.

6.6.4.2.14 The values of yield strength or proof strength shall be the values according to national or international material standards. When austenitic steels are used, the specified minimum values according to the material standards may be increased by up to 15 % when greater values are attested in the material inspection certificate. When no material standard exists for the metal in question, or when non-metallic materials are used the values of yield strength or proof strength shall be approved by the competent authority.

6.6.4.2.15 Portable tanks intended for the transport of flammable refrigerated liquefied gases shall be capable of being electrically earthed.

6.6.4.3 *Design criteria*

6.6.4.3.1 Shells shall be of a circular cross section.

6.6.4.3.2 Shells shall be designed and constructed to withstand a test pressure not less than 1.3 times the MAWP. For shells with vacuum insulation the test pressure shall not be less than 1.3 times the sum of the MAWP and 100 kPa (1 bar). In no case shall the test pressure be less than 300 kPa (3 bar) gauge pressure. Attention is drawn to the minimum shell thickness requirements, specified in 6.6.4.4.2 to 6.6.4.4.7.

6.6.4.3.3 For metals exhibiting a clearly defined yield point or characterized by a guaranteed proof strength (0.2 % proof strength, generally, or 1 % proof strength for austenitic steels) the primary membrane stress σ (sigma) in the shell shall not exceed 0.75 Re or 0.50 Rm, whichever is lower, at the test pressure, where:

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*/ *For calculation purposes g = 9.81 m/s².*

Re = yield strength in N/mm^2, or 0.2 % proof strength or, for austenitic steels, 1% proof strength;

Rm = minimum tensile strength in N/mm^2.

6.6.4.3.3.1 The values of Re and Rm to be used shall be the specified minimum values according to national or international material standards. When austenitic steels are used, the specified minimum values for Re and Rm according to the material standards may be increased by up to 15 % when greater values are attested in the material inspection certificate. When no material standard exists for the metal in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body.

6.6.4.3.3.2 Steels which have a Re/Rm ratio of more than 0.85 are not allowed for the construction of welded shells. The values of Re and Rm to be used in determining this ratio shall be the values specified in the material inspection certificate.

6.6.4.3.3.3 Steels used in the construction of shells shall have an elongation at fracture, in %, of not less than 10,000/Rm with an absolute minimum of 16 % for fine grain steels and 20 % for other steels. Aluminium and aluminium alloys used in the construction of shells shall have an elongation at fracture, in %, of not less than 10,000/6Rm with an absolute minimum of 12 %.

6.6.4.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1984 using a 50 mm gauge length.

6.6.4.4 *Minimum shell thickness*

6.6.4.4.1 The minimum shell thickness shall be the greater thickness based on:

(a) the minimum thickness determined in accordance with the requirements in 6.6.4.4.2 to 6.6.4.4.7; and

(b) the minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.6.4.3.

6.6.4.4.2 Shells of not more than 1.80 m in diameter shall be not less than 5 mm thick in the reference steel or of equivalent thickness in the metal to be used. Shells of more than 1.80 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.6.4.4.3 Shells of vacuum-insulated tanks of not more than 1.80 m in diameter shall be not less than 3 mm thick in the reference steel or of equivalent thickness in the metal to be used. Such shells of more than 1.80 m in diameter shall be not less than 4 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.6.4.4.4 For vacuum-insulated tanks, the aggregate thickness of the jacket and the shell shall correspond to the minimum thickness prescribed in 6.6.4.4.2, the thickness of the shell itself being not less than the minimum thickness prescribed in 6.6.4.4.3.

6.6.4.4.5 Shells shall be not less than 3 mm thick regardless of the material of construction.

6.6.4.4.6 The equivalent thickness of a metal other than the thickness prescribed for the reference steel in 6.6.4.4.2 and 6.6.4.4.3 shall be determined using the following equation:

$$e_1 = \frac{21.4 \times e_o}{3\sqrt{Rm_1 \times A_1}}$$

where:

e_1 = required equivalent thickness (in mm) of the metal to be used;
e_o = minimum thickness (in mm) of the reference steel specified in 6.6.4.4.2 and 6.6.4.4.3;
Rm_1 = guaranteed minimum tensile strength (in N/mm^2) of the metal to be used (see 6.6.4.3.3);
A_1 = guaranteed minimum elongation at fracture (in %) of the metal to be used according to national or international standards.

6.6.4.4.7 In no case shall the wall thickness be less than that prescribed in 6.6.4.4.1 to 6.6.3.4.5. All parts of the shell shall have a minimum thickness as determined by 6.6.4.4.1 to 6.6.4.4.6. This thickness shall be exclusive of any corrosion allowance.

6.6.4.4.8 There shall be no sudden change of plate thickness at the attachment of the ends (heads) to the cylindrical portion of the shell.

6.6.4.5 *Service equipment*

6.6.4.5.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. When the connection between the frame and the tank or the jacket and the shell allows relative movement, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, shut-off devices), the stop-valve and its seating shall be protected against the danger of being wrenched off by external forces (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.6.4.5.2 Each filling and discharge opening in portable tanks used for the transport of flammable refrigerated liquefied gases shall be fitted with at least three mutually independent shut-off devices in series, the first being a stop-valve situated as close as reasonably practicable to the jacket, the second being a stop-valve and the third being a blank flange or equivalent device. The shut-off device closest to the jacket shall be a quick closing device, which closes automatically in the event of unintended movement of the portable tank during filling or discharge or fire engulfment. This device shall also be possible to operate by remote control.

6.6.4.5.3 Each filling and discharge opening in portable tanks used for the transport of non-flammable refrigerated liquefied gases shall be fitted with at least two mutually independent shut-off devices in series, the first being a stop-valve situated as close as reasonably practicable to the jacket, the second a blank flange or equivalent device.

6.6.4.5.4 For sections of piping which can be closed at both ends and where liquid product can be trapped, a method of automatic pressure relief shall be provided to prevent excess pressure build-up within the piping.

6.6.4.5.5 Vacuum insulated tanks need not have an opening for inspection.

6.6.4.5.6 External fittings shall be grouped together so far as reasonably practicable.

6.6.4.5.7 Each connection on a portable tank shall be clearly marked to indicate its function.

6.6.4.5.8 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the shell taking into account the temperature expected during transport. All stop-valves with a screwed spindle shall be closed by a clockwise motion of the handwheel. In the case of other stop-valves the position (open and closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed to prevent unintentional opening.

6.6.4.5.9 When pressure-building units are used, the liquid and vapour connections to that unit shall be provided with a valve as close to the jacket as reasonably practicable to prevent the loss of contents in case of damage to the pressure-building unit.

6.6.4.5.10 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of a suitable material. To prevent leakage due to fire, only steel piping and welded joints shall be used between the jacket and the connection to the first closure of any outlet. The method of attaching the closure to this connection shall be to the satisfaction of the competent authority or its authorized body. Elsewhere pipe joints shall be welded when necessary.

6.6.4.5.11 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525°C. The joints shall not decrease the strength of the tubing as may happen by cutting of threads.

6.6.4.5.12 The materials of construction of valves and accessories shall have satisfactory properties at the lowest operating temperature of the portable tank.

6.6.4.5.13 The burst pressure of all piping and pipe fittings shall be not less than the highest of four times the MAWP of the shell or four times the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief devices).

6.6.4.6 *Pressure-relief devices*

6.6.4.6.1 Every shell shall be provided with not less than two independent spring-loaded pressure-relief devices. The pressure-relief devices shall open automatically at a pressure not less than the MAWP and be fully open a pressure equal to 110% of the MAWP. These devices shall, after discharge, close at a pressure not lower than 10% below the pressure at which discharge starts and shall remain closed at all lower pressures. The pressure-relief devices shall be of the type that will resist dynamic forces including surge.

6.6.4.6.2 Shells for non-flammable refrigerated liquefied gases and hydrogen may in addition have frangible discs in parallel with the spring-loaded devices as specified in 6.6.4.7.2 and 6.6.4.7.3.

6.6.4.6.3 Pressure-relief devices shall be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.

6.6.4.6.4 Pressure-relief devices shall be approved by the competent authority or its authorized body.

6.6.4.7 *Capacity and setting of pressure-relief devices*

6.6.4.7.1 In the case of the loss of vacuum in a vacuum-insulated tank or of loss of 20 % of the insulation of a tank insulated with solid materials, the combined capacity of all pressure-relief devices installed shall be sufficient so that the pressure (including accumulation) inside the shell does not exceed 120 % of the MAWP.

6.6.4.7.2 For non-flammable refrigerated liquefied gases (except oxygen) and hydrogen, this capacity may be achieved by the use of frangible discs in parallel with the required safety-relief devices. Frangible discs shall rupture at nominal pressure equal to the test pressure of the shell.

6.6.4.7.3 Under the circumstances described in 6.6.4.7.1 and 6.6.4.7.2 together with complete fire engulfment the combined capacity of all pressure-relief devices installed shall be sufficient to limit the pressure in the shell to the test pressure.

6.6.4.7.4 The required capacity of the relief devices shall be calculated in accordance with a well-established technical code recognized by the competent authority*/.

6.6.4.8 *Marking of pressure-relief devices*

6.6.4.8.1 Every pressure-relief device shall be plainly and permanently marked with the following:

(a) the pressure (in bar or kPa) at which it is set to discharge;

(b) the allowable tolerance at the discharge pressure for spring-loaded devices;

(c) the reference temperature corresponding to the rated pressure for frangible discs; and

(d) the rated flow capacity of the device in standard cubic meters of air per second (m^3/s).

When practicable, the following information shall also be shown:

(e) the manufacturer's name and relevant catalogue number.

6.6.4.8.2 The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:1996.

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*/ *See for example CGA Pamphlet S-1.2-1995.*

6.6.4.9 *Connections to pressure-relief devices*

6.6.4.9.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except when duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that the requirements of 6.6.4.7 are always fulfilled. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Pipework to vent the vapour or liquid from the outlet of the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

6.6.4.10 *Siting of pressure-relief devices*

6.6.4.10.1 All pressure-relief device inlets shall be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure that the escaping vapour is discharged unrestrictedly. For refrigerated liquefied gases, the escaping vapour shall be directed away from the tank and in such a manner that it cannot impinge upon the tank. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

6.6.4.10.2 Arrangements shall be made to prevent access to the devices by unauthorized persons and to protect the devices from damage caused by the portable tank overturning.

6.6.4.11 *Gauging devices*

6.6.4.11.1 Unless a portable tank is intended to be filled by weight, it shall be equipped with one or more gauging devices. Glass level-gauges and gauges made of other fragile material, which are in direct communication with the contents of the shell shall not be used.

6.6.4.11.2 A connection for a vacuum gauge shall be provided in the jacket of a vacuum-insulated portable tank.

6.6.4.12 *Portable tank supports, frameworks, lifting and tie-down attachments*

6.6.4.12.1 Portable tanks shall be designed and constructed with a support structure to provide a secure base during transport. The forces specified in 6.6.3.2.9 and the safety factor specified in 6.6.3.2.10 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.4.12.2 The combined stresses caused by portable tank mountings (e.g. cradles, frameworks, etc.) and portable tank lifting and tie-down attachments shall not cause excessive stress in any portion of the tank. Permanent lifting and tie-down attachments shall be fitted to all portable tanks. Preferably they shall be fitted to the portable tank supports but may be secured to reinforcing plates located on the tank at the points of support.

6.6.4.12.3 In the design of supports and frameworks the effects of environmental corrosion shall be taken into account.

6.6.4.12.4 Forklift pockets shall be capable of being closed off. The means of closing forklift pockets shall be a permanent part of the framework or permanently attached to the framework. Single compartment portable tanks with a length less than 3.65 m need not have closed off forklift pockets provided that:

(a) the tank and all the fittings are well protected from being hit by the forklift blades; and

(b) the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.6.4.12.5 When portable tanks are not protected during transport, according to 4.2.3.3, the shells and service equipment shall be protected against damage to the shell and service equipment resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;

(b) protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact which may consist of a bumper or frame;

(d) protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995;

(e) protection of the portable tank from impact or overturning by a vacuum insulation jacket.

6.6.4.13 *Design approval*

6.6.4.13.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the refrigerated liquefied gases allowed to be transported, the materials of construction of the tank and jacket and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Any alternative arrangements according to 6.6.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.6.4.13.2 The prototype test report for the design approval shall include at least the following:

(a) the results of the applicable frame-work test specified in ISO 1496-3: 1995;

(b) the results of the initial inspection and test in 6.6.4.14.3; and

(c) the results of the impact test in 6.6.4.14.1,when applicable.

6.6.4.14 *Inspection and testing*

6.6.4.14.1 For portable tanks meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype portable tank shall be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4 g) the MPGM of the fully loaded portable tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads,
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600), 1992

Canadian Standards Association (CSA),
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods (B620-1987)

Deutsche Bahn AG
Zentralbereich Technik, Minden
Portable tanks, longitudinal dynamic impact test

Société Nationale des Chemins de Fer Français
C.N.E.S.T. 002-1966.
Tank containers, longitudinal external stresses and dynamic impact tests

Spoornet, South Africa
Engineering Development Centre (EDC)
Testing of ISO Tank Containers
Method EDC/EST/023/000/1991-06

6.6.4.14.2 The tank and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.6.4.14.7.

6.6.4.14.3 The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank shell and its fittings with due regard to the refrigerated liquefied gases to be transported, and a pressure test referring to the test pressures according to 6.6.4.3.2. The pressure test may be performed as a hydraulic test or by using another liquid or

gas with the agreement of the competent authority or its authorized body. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the shell and its fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test. All welds subject to full stress level shall be inspected during the initial test by radiographic, ultrasonic, or another suitable non-destructive test method. This does not apply to the jacket.

6.6.4.14.4 The 5 and 2.5 year periodic inspection and test shall include an external examination of the portable tank and its fittings with due regard to the refrigerated liquefied gases transported, a leakproofness test, a test of the satisfactory operation of all service equipment and a vacuum reading, when applicable. In the case of non-vacuum insulated tanks, the jacket and insulation shall be removed during a 2.5 year and a 5 year periodic inspection but only to the extent necessary for a reliable appraisal.

6.6.4.14.5 In addition, at the 5 year periodic inspection and test of non-vacuum insulated tanks the jacket and insulation shall be removed, but only to the extent necessary for a reliable appraisal.

6.6.4.14.6 A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 6.6.4.14.2. However a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

(a) after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

(b) unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.6.4.14.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, leakage, or any other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.6.4.14.4.

6.6.4.14.8 The internal examination during the initial inspection and test shall ensure that the shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, that might render the portable tank unsafe for transport.

6.6.4.14.9 The external examination of the portable tank shall ensure that:

(a) the external piping, valves, pressurizing/cooling systems when applicable and gaskets are inspected for corroded areas, defects, or any other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or transport;

(b) there is no leakage at any manhole covers or gaskets;

(c) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

(d) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;

(e) required markings on the portable tank are legible and in accordance with the applicable requirements; and

(f) the framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.

6.6.4.14.10 The inspections and tests in 6.6.4.14.1, 6.6.4.14.3, 6.6.4.14.4, 6.6.4.14.5 and 6.6.4.14.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.

6.6.4.14.11 In all cases when cutting, burning or welding operations on the shell of a portable tank have been effected, that work shall be to the approval of the competent authority or its authorized body taking into account the pressure vessel code used for the construction of the shell. A pressure test to the original test pressure shall be performed after the work is completed.

6.6.4.14.12 When evidence of any unsafe condition is discovered, the portable tank shall not be returned to service until it has been corrected and the test is repeated and passed.

6.6.4.15 *Marking*

6.6.4.15.1 Every portable tank shall be fitted with a corrosion resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When for reasons of portable tank arrangements, the plate cannot be permanently attached to the shell, the shell shall be marked with at least the information required by the pressure vessel code. As a minimum at least the following information shall be marked on the plate by stamping or by any other similar method:

Country of manufacture

U	Approval	Approval	In case of Alternative Arrangements
N	Country	Number	"AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure vessel code to which the tank is designed

Test pressure _____bar/kPa gauge */

MAWP_____ bar/kPa gauge */

Minimum design temperature _____°C

Water capacity at 20°C _____litres

Initial pressure test date and witness identification

Shell material(s) and material standard reference(s)

Equivalent thickness in reference steel _____mm

Date and type of most recent periodic test(s)

Month_____ Year_____ Test Pressure_____bar/kPa gauge */

Stamp of expert who performed or witnessed the most recent test _____

The names, in full, of the gases for whose transport the portable tank is approved

Either "thermally insulated" or "vacuum insulated"_____

effectiveness of the insulation system (heat influx)_____Watts (W)

Reference holding time_____days or hours and initial pressure_____bar/kPa gauge */ and degree of filling_____ in kg for each refrigerated liquefied gas permitted for transport.

6.6.4.15.2 The following information shall be durably marked either on the portable tank itself or on a metal plate firmly secured to the portable tank.

Name of the owner and the operator

Name of the refrigerated liquefied gas being transported (and minimum mean bulk temperature)

Maximum permissible gross mass (MPGM)_____kg

Unladen (tare) mass_____kg

Actual holding time for gas being transported _____days (or hours)

***NOTE**: For the identification of the refrigerated liquefied gas(es) being transported, see also Part 5.*

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*/ *The unit used shall be marked.*